00	06/09/2013	PRIMA EMISSIONE	AB	DB	DB
REVISIONE		DESCRIZIONE	EL.	CON.	APP.

MINISTERO DELLE INFRASTRUTTURE E DEI TRASPORTI

MAGISTRATO ALLE ACQUE

NUOVI INTERVENTI PER LA SALVAGUARDIA DI VENEZIA

LEGGE N. 798 DEL 29-11-1984
CONVENZIONE REP. 7191 DEL 04-10-1991
ATTO ATTUATIVO REP. 8249 DEL 28-12-2007 (PROGETTAZIONE)
ATTO ATTUATIVO REP. 8492 DEL 30-03-2011 (LAVORI)

INTERVENTI ALLE BOCCHE LAGUNARI PER LA REGOLAZIONE DEI FLUSSI DI MAREA

CUP: D51B020000500H1 (LAVORI)

PROGETTO ESECUTIVO

WBS: LN.L1.50 - BOCCA DI LIDO. IMPIANTI
WBE: LN.L1.50.PE.15 - MEZZO RIMOZIONE SEDIMENTI

PROGETTO MOSE

MEZZO RIMOZIONE SEDIMENTI

SPECIFICA TECNICA
PROPULSORI, MOTORI ELETTRICI E CONVERTITORI

ELABORATO COMAR SCARL	CONTROLLATO COMAR SCARL	APPROVATO COMAR SCARL
A. Benvenuti	D. Berti	D. Berti
N. ELABORATO	**REVISIONE**	**DATA**
MOL150-IM0093-S092	00	06/09/2013

COORDINAMENTO PROGETTAZIONE

VERIFICATO V. Ardone

CONTROLLATO M. Brotto

CONSORZIO VENEZIA NUOVA

COMAR
COstruzioni MOSE ARsenale

MINISTERO DELLE
MINISTERO DELLE INFRASTRUTTURE E DEI TRASPORTI
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WBS: LN.L1.50
BOCCA DI LIDO: S. NICOLO' - TREPORTI - IMPIANTI
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MEZZO RIMOZIONE SEDIMENTI

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SPECIFICA TECNICA
PROPULSORI, MOTORI ELETTRICI E CONVERTITORI

Indice Allegati

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2		Two (2) Schottel Tunnel Thrusters - type STT 170 T two for installation in bow - Technical Specification	31
3	MEV0136	Installation Drawing	1
4	STT170TLK-E-MOTOR-4	Propeller blades (tunnel thrusters)	1

Technical Specification
MEV-130136-01 / order no. / order code word

TWO (2) SCHOTTEL RUDDERPROPELLER

TYP SRP 550 FP

AS MAIN PROPULSION UNITS

Vessel type	: Dredger
Operation area	: Italy, Sea
class	: RINA
class notation	: C ✠ Hopper Dredger Coastal Area AUT-IMS DYNAPOS AM/AT

CONTENTS

1. SCOPE OF SUPPLY

1.1 List of components supplied by SCHOTTEL

- 2x SRP 0550 FP including nozzle
- Parts per thruster:
- steering system parts, according to chapter steering system
- Prime mover, Typ: Asynchrony frequency controlled electric motor
- Frequency converter(Active front End)for control of electric prime mover
- Shaftline parts, configuration according to chapter power transmission
- 1x Forward bridge parts, configuration according to chapter desk configuration
- 1x Switch cabinet for SCHOTTEL control system
- 1x Switch cabinet for SCHOTTEL power part steering system
- 1x Brake resistor for SCHOTTEL power part steering system
- per ship set:
- 1x Toolset consisting of:
  - Tools for dismounting of propeller
  - Tools for dismounting of power input flange
  - Tools for lower oil drainage
  - Toolbox
- 1x Spare parts to be supplied according to requirements of classification societies for simple maintenance and service work to be done by onboard personnel, basically consisting of:
  - Mechanical parts:
    This includes at least hydraulic hoses, upper gear box sealings, belts, oil filters, anodes for coolers (one of each), as far as the unit is equipped with these items.
  - Electrical parts:
    one set of printed circuit boards, relays and LEDs (depends on construction of electrical system)

1.2 Additional agreements

This technical specification describes SCHOTTEL standard units. In case of discrepancies and/or contradictions, the additional agreements shall prevail over all other parts of the technical specification.

1) Specification of AFE frequency control fresh water cooled:

The Frequency Converter offered comprises the following assembled modules:
Rectifier
Inverter
Control Unit
Connecting Bus bars

Operation:
The rectifier creates the DC Bus that powers the inverter modules. The inverter powers the motor, supply frequency and voltage that vary in line with the torque and speed settings. The inverter comprises IGBT's power modules.
The whole assembly is controlled by a parameterized control unit using a coloured touch screen

General Data General Data
Rated Power for Frequency Converter (1): 1100 kW (2) – 690 Vac based on 38°C fresh water entry temperature.
Cooling: fresh Water
Configuration: AFE + Inverter

Electrical Characteristics
input Voltage: 690 Vac
Voltage Fluctuations: +10% / -10%
Input Current (1): 1020 Aac
Input Frequency: 50/60 Hz ± 5%
Power Factor:
Fundamental: 1
Total: 0.99
Output Voltage: 0 Vac up to Input Voltage
Output Frequency: 0 – 120 Hz
Output Current (1): 1089 Aac
Efficiency at 100% of the Rated Operating Point: 96%
Semiconductors switching frequency: 2.5 kHz
Service: S1
(1) See Derating Tables
(2) Based on a motor of η =0.95 and cos (phi) =0.89

Standard Features
Analog Inputs Available: 4
Analog Outputs Available: 4
Digital Inputs Available: 17
Digital Outputs Available: 20
Local Control Panel
Fresh Water Cooling (Primary)
Input Filter
Lighting and socket in control cabinet
Main Circuit Breaker
Operation Touch Screen
Remote control and troubleshooting via Ethernet interface
Redundant Pumping Set Fixing rods and door retainers

Drive Control
Static Speed Accuracy in Closed Loop (6):
Constant Flux: < 0.01%

In field weakening: < 0.01%
Static Torque Accuracy in Closed Loop (6):
Constant Flux: < 1%
In field weakening: < 1%
Shaft Torque Ripple:
Constant Flux: < 3%
In field weakening: < 5%
Torque Response Time:
< 10 ms
Triggering Drivers Control:
Via Optic Fibre
Drive Protections:
Overcurrent
Output Shortcircuit
Overload on the Frequency Converter
Over / Low voltage on the DC Bus
IGBT Fault
Cooling fault
Unbalance between motor phases
Rectifier or Inverter unconnected phases
Motor Protections:
(6) Referred to maximum values of equipment
Overload
Overspeed

Auxiliary Power
Voltage/Power rated: 400 - 500 Vac ± 10% – 8 kVA
Voltage Fluctuations: ± 10%
Operating Frequency: 50 / 60 Hz, ± 5%

Drive Construction
Enclosure (9): IP44
Colour (9): RAL 7035
Dimension W / H / D (mm): 2400 / 2165 / 600
Approximate Weight (kg) : 2000 Kg. (Approx.)
Input Power Connections Access: At the Bottom
Output Power Connections Access: At the Bottom
Power input Glands (Rectifier) (10): 8 unit Φ 28 to 54 mm.
Power output Glands (Inverter) (10): 9 unit Φ 28 to 54 mm.
Control input Glands: 27 unit Φ 3.5 to 16.5 mm

Ambient Conditions
Min. Operating Temperature of Air: + 5 °C
Max. Operating Temperature of Air (11): + 45 °C (100% Power)
Min. Storage and Transportation Temperature Range (12): - 25 °C
Max. Storage and Transportation Temperature Range: + 75 °C

Humidity: 5% to 95% (non-condensing)
Audio Noise: < 75 dB
(10) Same number of cables for each phase
(11) See Derating Tables
(12) For empty cooling system

Drive Cooling

Cooling System: Water Cooling Unit
Primary Circuit Coolant: Fresh Water
Min. Input Coolant Temperature (13): 0 °C (no frost allowed)
Max. Input Coolant Temperature (13): + 45 °C (based on 1000 kW power or less)
Max. Losses to dissipate: 44 kW (at Rated Power)
Loss to the environment at 25°C: 2.2 kW (at Rated Power)
Coolant Flow (Primary Circuit): 128 l/min (min. Flow to rated power kW)
ΔP Coolant Flow (Primary Circuit): < 1 bar
Pmax Coolant Flow (Primary Circuit): 6 bar
ΔT Coolant Flow (Primary Circuit): 5 °C (at Rated Power)
(13) See Derating Tables
This frequency converter is of regenerative type. Therefore propeller wind milling energy must be fed back to the board net and this energy must be absorbed by the board net.
Please get in touch with SCHOTTEL if cable length between frequency converter and electric motor exceeds 20 m. In such case SCHOTTEL has to check, whether du/dt filter could become necessary!

2) Analogue power reduction Interface will be provided: 4 mA - 20 mA

3) A pmeumatic holding brake will be provided on power input shaft of each thruster.

2. TECHNICAL DATA

2.1. THRUSTER

Power applied to input shaft	: 800 kW
Input speed	: 1786 r.p.m
turning direction of Input shaft seen on input shaft,	
for thruster PS stern	: clockwise
for thruster Stbd stern	: clockwise
Type of construction	: Z-drive
Installation into vessel	: mounted from top, bolted, rubber gasket sealed
Propeller Arm /Stem length	: 2400 mm
Casing material lower gear box	: GGG40
Weight excl oil & auxiliaries	: 10,7 t (approximately)
Required oil charge	: 870 l (approximately)

Note: The final weight will be determined in the installation proposal.

Gear Reduction Ratio	: 5,059
Service factor	: 79%

Service factor is design torque (at above power and rpm) divided by max allowable peak torque in percent (only for short peaks allowable).

Max. allowed short input torque	: 5423 Nm
Nozzle	: WAG 19A modified

Thruster rating

Working hours	: < 5000 h / per annum
Load	: alternating max. 75% full load
Overload	: no overload (only with prime mover management)
Operation area	: Inland waterways with limited water depth, Restricted coastal service or Harbour service

Propeller Design

Propellerlayout

Diameter	: 1750 mm
Type	: Fixed Pitch (Push)
turning direction of propeller seen from AFT,	
for thruster PS stern	: clockwise
for thruster Stbd stern	: counter clockwise
Lay out material	: G-CuAl10Fe5Ni5-C (CU 3)
Number of blades	: 4
Design Type & Manufacturing Standard	: ISO 484/1981 (E). Tolerance Class I / II
Rating	: 800 kW

Propellers will be designed for free running to achieve max. suitable ship speed.

Steering

Type	: SCHOTTEL Steering-System SST 1002
Rotation Speed	: 12 sec. /180°

Components:
2 frequency controlled electric steering motor(s), including anti condensation heater, mounted on SRP
Input power :9 kW (each motor)

Sealing system

Propeller-, steering shaft sealing type : standard

2.2. PRIME MOVER

A frequency controlled 3 phase AC asynchronous motor with squirrel-cage rotor will be used as prime mover.

Rated power	: 800 kW
Rated rpm	: 0 - 1786 r.p.m.
Rated voltage	: 690 V
Rated frequency	: 0 - 60Hz
Rated duty	: S1
Installation	: IM B3
Frame size	: 400
Type of protection	: IP 55
Insulation class	: F / F
Special enclosures	: 6x sensor for winding temperatures, Anti condesation heater
Protection against condensation	: internal heating
Classification	: RINA

Fresh water motor cooling water data:
Cooling water entry: 38 °C
Cooling water quantity: 3,9 m^3/h
Max allowed cooling water pressure: 6 bar
Quantity of heat to be removed: 25,2 kW

The fresh water cooling pump is within yard supply.

An anti-condensation heating prevents the winding from corrosion at stand still condition, rated voltage is 230 V.
Incorporated temperature detectors protect the windings against over temperature.

Control Cabinet for Frequency Control

See Chapter "Additional Agreement".

2.3. POWER TRANSMISSION

shaft line elements

No.	Nomination

1 x Flexible shaft with elastic coupling

Shaftline length :1000 mm

Note: The final shaft line configuration will be determined on the basis of TVA calculations!

3. DESIGN & CONSTRUCTION

3.0 GENERAL ADVICES

Note: It is strongly recommended by SCHOTTEL to minimise the operation time in "high precise mode" and using the "relaxed mode" as much as possible. Since even that the high precision dynamic positioning systems control provides high accuracy station-keeping it does it at the expense of high power consumption and exposure to wear and tear of thrusters.

Note: It has to be assured that the e-motor does not deliver a higher torque than 4491 Nm to the SRP.
4491 Nm contains 5 % torque tolerance.
To control this SCHOTTEL shall get a load signal which shall be measured during commissioning. This signal shall be connected to the ships alarm system, thus if this load signal fails or shows an overload an overload alarm is released. This enables the crew to take corresponding measures to protect the thruster against overload.

3.1 GENERAL DESIGN FEATURES

Installation

The unit is supplied for well (well to be supplied by the yard) type mounting from above and has a mounting flange integral with the stem/steering gear casing. The mounting flange is bolted to the ship's structure and sealed by a flat rubber gasket. The thrust of the unit is transmitted through this flange connection only. Necessary mounting material is supplied by SCHOTTEL, i.e. bolts, washers and sealing.

Upper gearbox

Housing is made of spherocasting (GGG) and bolted to the thruster top plate. It contains a set of helicoidal bevel gears, topped by a header tank.
The cyclo-palloid-type gear wheel/pinion is case-hardened and finish-machined after hardening (H.P.G process) to Class 6 – DIN 3965.
All shafts in upper gear box are sealed by a lip-seal, running on a nitrated liner. All stationary parts are sealed by O-rings.

Top plate

The top plate or mounting plate is a support element between upper gear and support section.

Gearing

Below the topplate (within the support section) a slew bearing is located. It tops the steering hub and is driven by actuators with torque enforcement through planetary gear sets.

Steering drives

Multiple E-motors are part of the steering gear. They are flanged onto a planetary reduction gear set in order to achieve suitable rotating (steering) speed.

Thrust direction transmitter

A separate output shaft, driven by steering spur gear wheel is connected to a feedback transmitter (electrical and mechanical), mounted onto the topplate. Suitable reduction gives 1 : 1 synchronism with lower gearbox.

Support Section

The intermediate stem section is the connection between upper and lower gearbox. Vertical stiffeners giving stability to the stem section are used to carry the yard supplied well bottom cover plate. The stiffeners come with excess length to be cut by the yard according to the hull shape.
To allow proper cooling, the well bottom cover plate has to be fitted with annular gaps to allow water circulation in the well according to SCHOTTEL's recommendation, see installation drawing.

Steering pipe

Attached to the spur gear the steering pipe is the vertical connection between steering gear and lower gear housing. It is manufactured from high quality casting (see technical data), supported by solid roller bearing(s). Tightness is achieved by lip seals with additional dirt protection, running on a ceramic coated ring of stainless steel. Seals are easily accessible from outside of hull for inspection or change without dismounting of thruster.

Transmission shaft

Connection between upper and lower gear's power transmission is achieved by a vertical power transmission shaft, running inside the steering pipe. A helix or pump wheel between these two pipes, rotated by the vertical power transmission shaft, ensures constant oil circulation between upper and lower gear. Joint between upper gear, lower gear and vertical power transmission shaft is of involute splined shaft type.

Lower Gearbox

The streamlined housing is made of high quality casting (see technical data) and has an opening for fiberscope inspection.
It contains a set of cyclo-palloid-type bevel gears. The cyclo-palloid-type gear wheel/pinion is case-hardened and finish-machined after hardening (H.P.G process) to Class 6 – DIN 3965.
Tightness of propeller shaft is achieved by lip seals running on a tungsten carbide coated ring of stainless steel. Seals are easily accessible from outside of hull for inspection or change without dismounting of thruster. All stationary parts are sealed by O-rings.

Note: To prevent that nets and thin lines harm the propeller shaft sealings, the gap between propeller hub and lower gear box housing include a labyrinth construction, which cuts lines.

Lubrication system

An oil tank, directly mounted on top of upper gearbox, serves as compensating and expansion tank.
During operation oil circulates in the unit, beeing cooled down in the immersed lower section by heat dissipation through the surface of underwater parts to the surrounding water.
The upper gear box is drained by a lube oil pump to avoid splash losses and overheating of the lube oil.
During standstill, the upper gear is completely refilled with lube oil to prevent condensation and corrosion.

Standard Nozzle

Modified WAGENINGEN 19A design, built of shipbuilding steel, inner plating made from stainless steel, the nozzle is bolted to the thruster.

Structure of the nozzle is designed for speeds up to max 10 knots".

3.2 STEERING SYSTEM

SCHOTTEL Steering-System SST 1002

Function
This is a full-follow up (FFU) electric steering system with non-follow up (NFU) back-up system.
The SRP thrust can be directed to any desired direction around the vertical axis either by turning the Copilot steering lever (if SCHOTTEL scope of supply) or through external systems using a 4-20 mA signal.
The electronic control compares the presetting with the actual angle of the SRP and transmits a signal corresponding to the differential angle to the electric steering motor. If the presetting angle is not equal to the angle of the SRP the control will be aligned.
The proportional steering system works in such a way that with small angle of steering the corresponding steering speed is low and with bigger angle of steering the steering speed is higher. Thus the steering speed is proportionally regulated by the steering angle.
The SCHOTTEL SRP position is indicated via an electric feed-back system by a thrust direction indicator. The thrust direction is also shown by a mechanical indicator on the SRP.
In case of failure of the electronic FFU steering system, the steering is automatically switched over to a non-follow up (NFU) steering system.

Components
The electric steering is mounted on the SCHOTTEL SRP. SCHOTTEL will supply loose, for installation by the shipyard:

- 1 switchbox IP54 with digital programmable modules
- steering panel, see electric system
- 1 x 6 pulse frequency converter integrated in switchbox
- frequency controlled electric steering motor(s) mounted on SRP

4. AMBIENT CONDITIONS

Maximum environmental temperature during operation according to class requirements : 45°C

Maximum environmental operation conditions:
Mechanical system:

Ambient air temperature	: between 5°C and max. 55°C
Relative humidity of air	: max. 95% without condensation
Seawater temperature	: max. 32°C

Electric system:

Electric parts inside switchbox	: 0°C - 50°C
Bridge parts (inside)	: 0°C - 50°C
Bridge parts (outside)	: (-)20°C - 50°C
Relative humidity of air	: max. 95% without condensation
Vibration	: 0,7g

5. POWER SUPPLIES

Electrical

For safe operation of the propulsion system SCHOTTEL requires the following power supply from the ship's sources:

Switch cabinet

- 690V/50Hz, 3Ph AC main power supply from the main switch board to the power control system of the electric motor
- 400V/50Hz, 3Ph AC main power supply from the main switch board to the thruster control system.
- 230V/50Hz, 1Ph AC (F 16 A) power supply from the main switch board to the SCHOTTEL switch box in the engine room (e.g. for service plug).
- 24 V DC (+30% /-25%) with a max. ripple of 1 V (max. 300 W) for emergency operation of the SCHOTTEL switch box.
- 24 V DC (+30% /-25%) with a max. ripple of 1 V (fuse 2 A) from the emergency switch box to the steering desk for emergency power supply of each thrust direction indicator.

6. COATING AND PAINT STRUCTURE

Upper gearbox as well as other metal parts inside the ship
sand blasting SA 2 ½ acc. DIN EN ISO 12944-4: 1998-07

2 x 2K Epoxy layer of anticorrosive primer	approx. each 50-60µm
1 x 2K P.U. top coat, grey RAL 7000	approx. 50-60µm

Electric switchboxes*:
RAL 7035, structure

Panels*:
Black anodized aluminium

* If SCHOTTEL scope of supply.

Support section
sand blasting SA 2 ½ acc. DIN EN ISO 12944-4: 1998-07

1 x 2K Epoxy-resin-primer	approx. 40 - 50 µm
3 x abrasion resistant coating	3 x approx. 100 - 125 µm (2K Expoxy-resin)

Lower gearbox
sand blasting SA 2 ½ acc. DIN EN ISO 12944-4: 1998-07

1 x 2K Epoxy-resin-primer	approx. 40 - 50 µm
3 x abrasion resistant coating	3 x approx. 100 - 125 µm (2K Expoxy-resin)

Nozzle
sand blasting SA 2 ½ acc. DIN EN ISO 12944-4: 1998-07

1 x 2K Epoxy-resin-primer	approx. 40 - 50 µm
3 x abrasion resistant coating	3 x approx. 100 - 125 µm (2K Expoxy-resin)

Sacrificial Anodes
The outboard parts of each thruster are protected with anodes for at least 2 years:

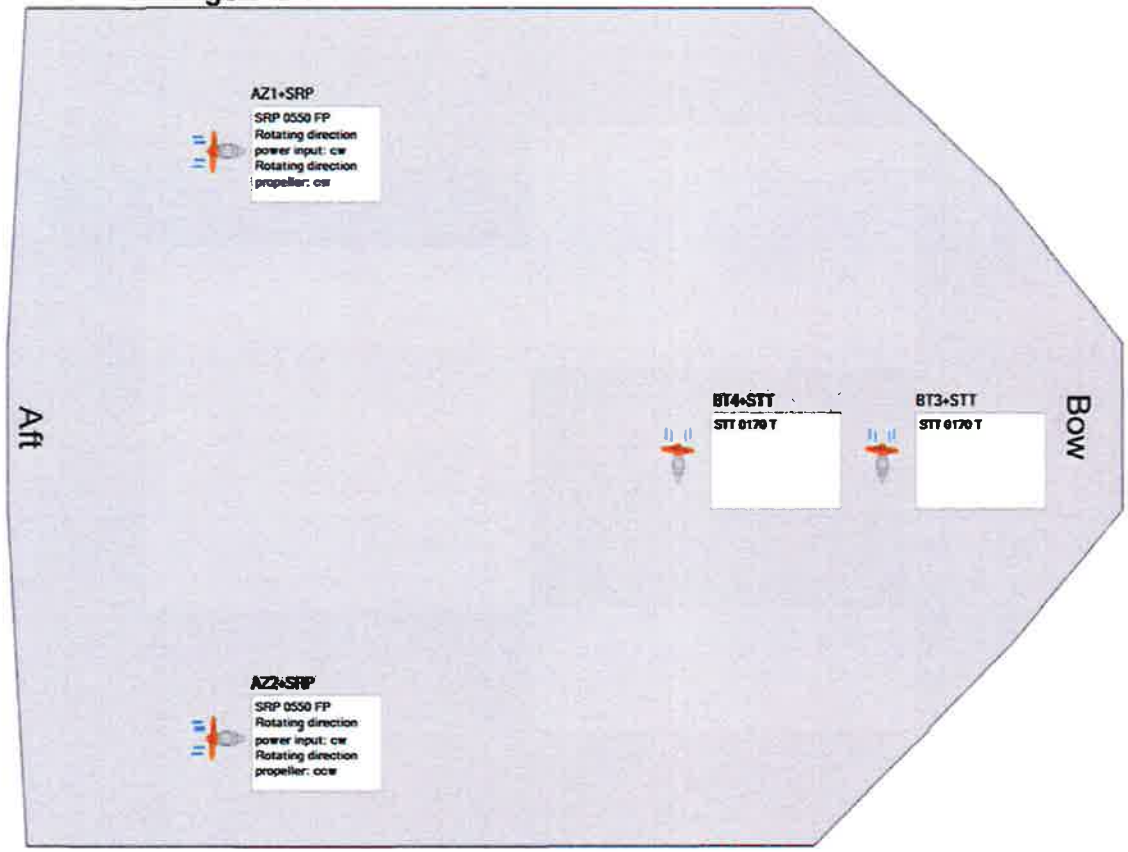
Fitted to the nozzle.

Material	: zinc
Mounting	: welded

7. ELECTRICAL SYSTEM

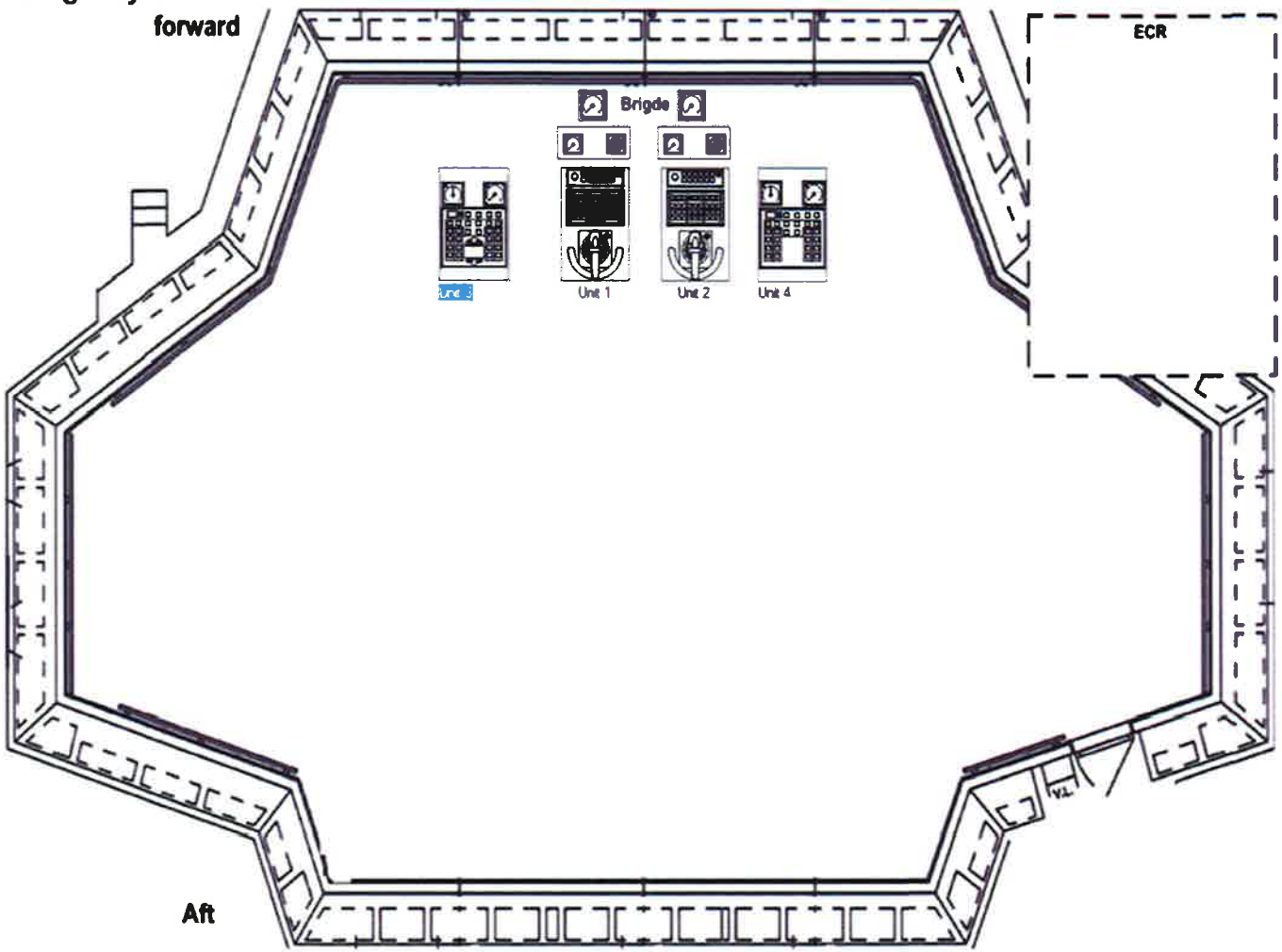
7.1. Unit arrangement

Thruster arrangement



Technical Specification
MEV-130136-01 / order no. / order code word

Bridge layout



Technical Specification
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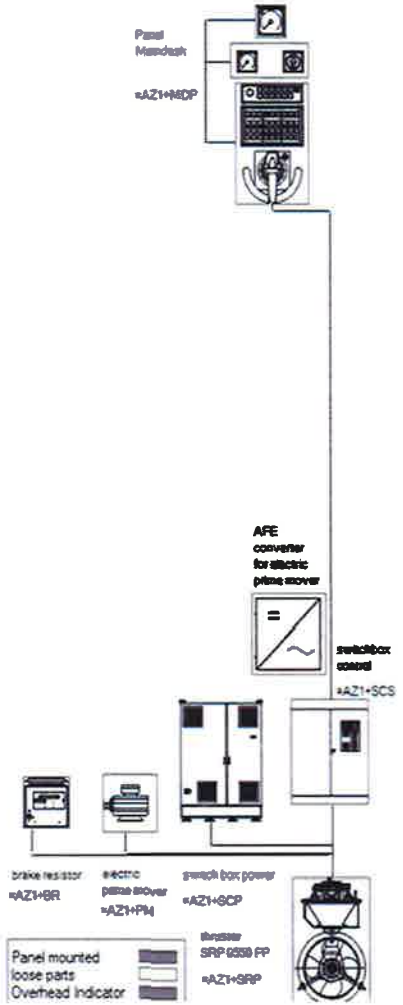
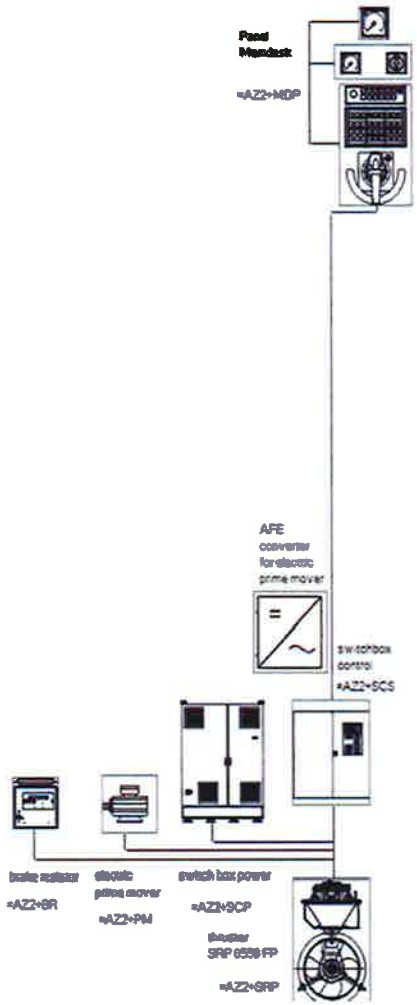
Unit arrangement





7.2. Switch cabinet

Switch cabinet control system

The switch cabinet is the central component of the electric system. Incoming AC voltage is converted and stabilized into 24 V DC voltage. Alternatively a 24V DC feed line is also possible. Furthermore all necessary control elements, printed circuit boards, fuses etc. are installed and wired inside. For easy connection of external cabling terminal blocks with corresponding numbering are used.

The switch cabinet will be supplied loose for installation according to local space requirement. Final position of switch cabinet should be selected regarding avoidance of extreme temperatures, humidity and vibration.

Type of protection: IP 23

Local Control Panels

The following components will be mounted into a control panel at the door of each control switch cabinet of the SCHOTTEL control system.

Controls (one for each thruster)

- "EMERGENCY STOP" push button
  - (only with electrical maindrive)
- Push buttons "NON FOLLOW UP STEERING"
- Push buttons "NON FOLLOW UP RPM-CONTROL"

Indicators (one for each thruster)

- Pilot lamps "NON FOLLOW UP STEERING ON"
- Pilot lamps "NON FOLLOW UP RPM-CONTROL ON"
- Thrust direction indicators with build-in illumination
- Shaft speed indicators with build-in illumination

Operation and Diagnostics-System Touch display (one for each thruster)

- Thrust direction indicator
- Shaft speed indicator
- Operation data
- Diagnostic system

BUS – System

Communication between control panels (if panels are in SCHOTTEL scope of supply) and switch cabinet control system in engine room is effected via a BUS system. For

the transport of data information in BUS system special shielded cables have to be applied, type TCX(c) (with twisted pair wires). Data transfer between panels and switch cabinet by shielded BUS cables may not be interrupted by terminals, due to the risk of electromagnetic disturbances. Power cables have to be separated from bus cables in cable channels. The recommended cable routings of SCHOTTEL are based on IEC 61000-5-2.
The minimum distance between the cables class 2 (carrying slightly sensitive signals) and class 4 (carrying strongly interfering signals) is specified with 500mm.

Switch cabinet power part

Components for the control of the electrical steering motors are installed into separate switch cabinets for each unit. The switch cabinet will be mounted in the engine control room.

Type of protection: IP 23

7.3. Desk configuration

Detailed description of control panel arrangement. See example below.
The following components will be delivered wired with a cable tree of 1,2 m length to terminal strips.

Labelling language : english

Main: Indicator: Mounting: loose Typ: Azimuth,RPM 96x96mm +Powerindicator 0-110%, loose, 96x96mm Drive-control-panel: Mounting: loose Control-Panel: Mounting: loose Lever: Mounting: loose Typ: Copilot with handwheel	**Aft:** not used
Stbd-Wing: not used	**PS-Wing:** not used
ECR: not used	

Desk changing between the wheel house and local panel in switch cabinet

The local control panel can be activated every time.

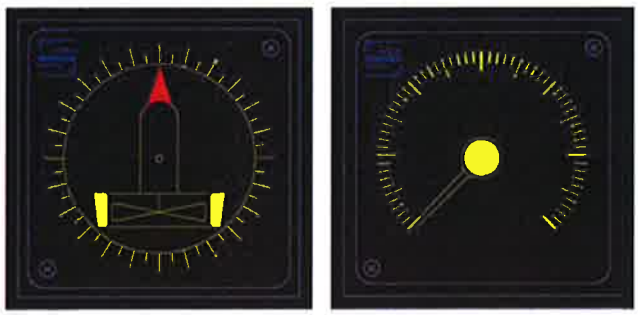
LOCAL CONTROL

With this push button the local control panel can be switched ON every time. After pushing "LOCAL CONTROL", on the panel which lost the control a sound signal will activated for 3s, during this time the pilot lamp "LOCAL CONTROL" is flashing. After the 3s the sound signal will be switched of and the pilot lamp is continuous lighting.

Command from local control to wheel house

To transfer the control from local to the wheelhouse, the actual speed value must be in zero position and the push button "REMOTE CONTROL" on the activated local control console must be pressed. A pilot lamp is flashing to indicate that the transfer is activated.
On the control panel to which the control will be selected the push button "TAKE OVER" is flashing. A sound signal is activated for 3s. To take over the command the button "TAKE OVER" must be pressed on the panel which shall take over the command. After pressing the button the sound signal will be switched OFF and the pilot lamp from the activated desk is continuous lighting.

Indicators



Azimuth Speed

Desk control Panel

Figure may be differing from the sold panel.

Drive control panel

Figure may be differing from the sold panel.

Control Lever

Copilot with handwheel


SCHOTTEL

7.4 Interfaces & alarms

Interface to Autopilot-System

An interface for an Autopilot system is added. This function can be switched on from the SCHOTTEL control panel (**only on main desk** and if certain conditions are fulfilled). The Autopilot controls a steering angle of ± 45 degrees to the ahead thrust direction. Override function of Autopilot is included via copilot lever control.

The following signals are sent to the AP-system:
- Potential free contacts "AP ON"

The following signals are sent by the AP-system:
- Steering angle setpoint 4-20mA signal for -45/+45 degrees
- Potential free contact "AP ready"

Interface to Dynamic Positioning System

The DP interface includes handshake between propulsion control system and DP-system. The steering angle and RPM are handed over to the DP system.

The following signals are sent to the DP-system:
- Steering angle feedback 4-20mA signal for -180/+180 degrees
- Propeller RPM feedback 4-20mA signal for zero/max RPM
- Potential free contacts "Thruster ready" and "thruster running"

Note: Loop monitoring of 4-20mA signals by DP-supplier

The following signals are sent by the DP-system:
- Steering angle setpoint 4-20mA signal for -180/+180 degrees
- Propeller RPM setpoint 4-20mA signal for zero/max RPM
- Potential free contact "DP ON"

Note: Loop monitoring of 4-20mA signals by SCHOTTEL

Interface to Joystick System

The JS interface includes handshake between propulsion control system and JS-system. The steering angle and RPM are handed over to the JS system.

The following signals are sent to the JS-system:
- Steering angle feedback 4-20mA signal for -180/+180 degrees
- Propeller RPM feedback 4-20mA signal for zero/max RPM
- Potential free contacts "Thruster ready" and "thruster running"

Note: Loop monitoring of 4-20mA signals by JS-supplier

The following signals are sent by the JS-system:
- Steering angle setpoint 4-20mA signal for -180/+180 degrees
- Propeller RPM setpoint 4-20mA signal for zero/max RPM
- Potential free contact "JS ON"

Note: Loop monitoring of 4-20mA signals by SCHOTTEL

Interface to Drive Motor

The prime mover can be controlled (start, stop, power mode, etc.) via the SCHOTTEL drive control panel.

Interface to Conning-System

SCHOTTEL provides following signals to the Conning System **(RS422, NMEA 0183):**

- Actual speed value to engine (set point)
- Nominal value speed setting (feed back)
- Actual value shaft speed
- Nominal value steering setting (set point)
- Actual value steering (feed back)
- Actual activated desk
- Actual activated external system

Alarms

SCHOTTEL supplies potential free contacts to the ship warning unit. The alarm signals are available at the terminals of the switch cabinets and the connection boxes of the components. The signals for alarm suppressing are also connected to these terminals.

For indication of a common alarm on the SCHOTTEL desk control panels (if panels are in SCHOTTEL scope of supply) it is necessary that a potential free signal for "common alarm" will be delivered from the ship warning unit back to the SCHOTTEL control system.

All alarms that are required according to class requirements for rudder machinery will be indicated as "STATUS-SIGNALS" on the SCHOTTEL bridge panel (if panels are in SCHOTTEL scope of supply).

For detailed information about the alarm transmitter connection, see the attachment "Interface Description".

8. TECHNICAL DOCUMENTATION

- Installation documents (language: english) by e-mail in advance.
- Operation manuals (6 x paper & 1 x CD, language: english)

9. COMMISSIONING

One service engineer(s) for in total 21 (twenty one) working days (10 hours/day) for final check and commissioning per ship set. This also includes travel expenses and accommodation for in total two trip(s).

If further days or travels are necessary which were not caused by SCHOTTEL, the SCHOTTEL Service Price List valid at the time of the performance applies.

If applicable, participation at sea acceptance tests, harbour acceptance tests, FMEAs, site acceptance tests, bollard pull tests or similar will be charged as above, as SCHOTTEL has limited influence on duration.

10. TEST & CERTIFICATES

The propulsion system will be supplied with a certificate of: RINA

SCHOTTEL will effect the following tests:
- FAT for electrical & mechanical system

11. EXCLUSIONS

- Outer Wells
- Bottom plates of azimuth thrusters
- All cable glands for junction boxes, IP 54 cabinets and motors. The amount and dimensions of cable glands vary depending on cable types and makes used and the kind of guiding the cables and therefore it is impossible to deliver them in a correct manner.
- Wing and bridge aft control panels
- Autopilot
- DP-System
- Machinery materials such as electric power supply, lube oil, hydraulic oil, cooling water, compressed air, batteries
- Torsional Vibration Analysis (SCHOTTEL will provide a TVA for their scope of supply, the TVA for the complete propulsion system including prime mover will be set up by others)
- Protection of all moving parts, especially shaftline
- Installation of the system / components
- Electrical and hydraulic connections between SCHOTTEL-components and ship's sources
- Alarm system (other than mentioned alarm contacts)
- All parts not specifically indicated in the above specification as being part of our scope of supply.

Appendix A: INTERFACE DESCRIPTION

Example

For azimuth thrusters:

=AZX+SCS, in interface list

X is the number of thruster
1 = Aft Azimuth thruster, port
2 = Aft Azimuth thruster, starboard

For retractable azimuth thrusters:

=RTX+SCS, in interface list

X is the number of thruster, enumeration of thruster numbers is from stern to bow

For bow thrusters:

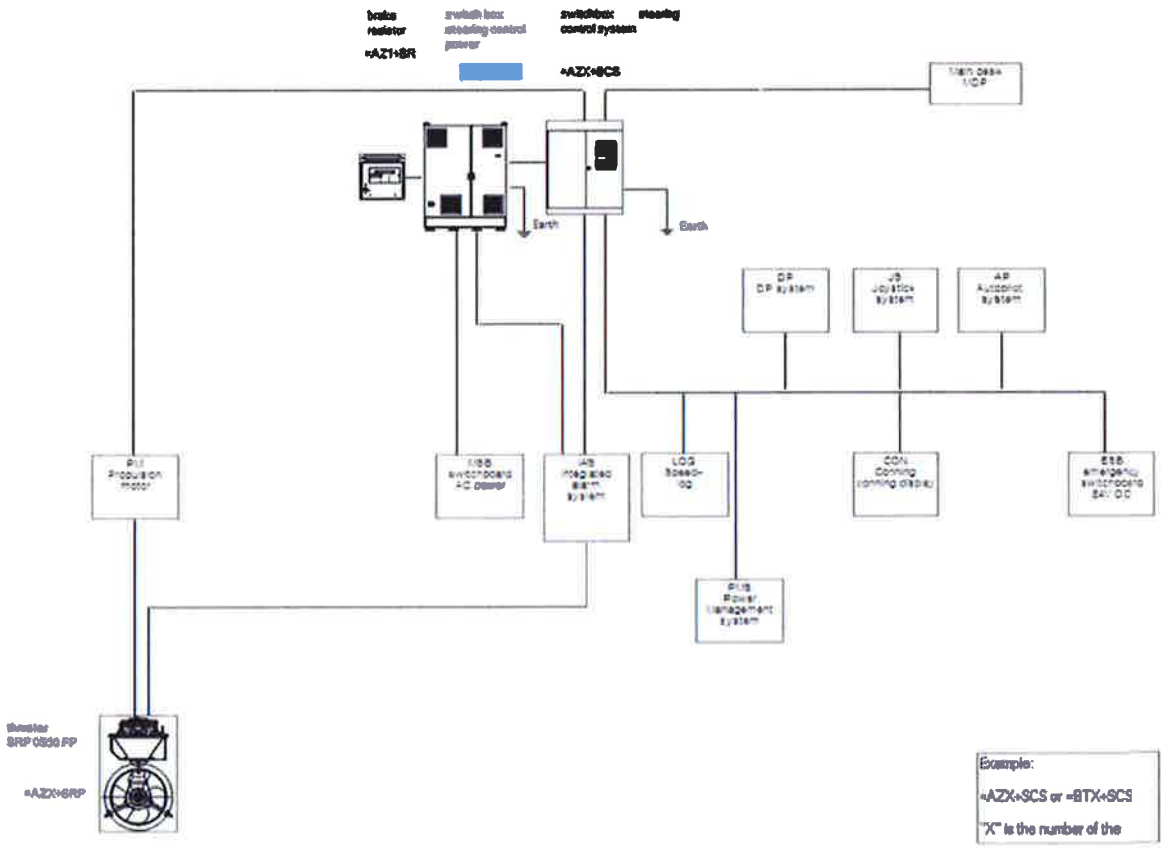
=BTX+SCS, in interface list

X is the number of thruster, enumeration of thruster numbers is from stern to bow

1 Contents

nomination	description
SCS	Switch cabinet steering control system
SCP	Switch cabinet steering control power
SRP	rudder propeller
MDP	Main Desk Panel
MSB	main switch board 400V/50Hz
PM	Propulsion motor
PMS	Power management system
IAS	integrated alarm system, warning unit
ESB	Emergency switchboard 24V DC
LOG	Speed Log
AP	Autopilot- /Trackpilot-System
DP	Dynamic-Positioning-System
JS	Joystick-System
CON	Conning System

2 Overview Interfaces



Power supply

AC power supply control system

=AZX+SCP	signal specification	terminal no.		signal direction	terminal no.		signal specification	MSB
Feed line Control system	L1 L2 L3	-S1	2 4 6	⇦			Fused	400V/50Hz
Earth connection	PE	-X1	4	⇦			Earth connection	
Feed line (e.g. for service plug)	L N	-X1	25 26	⇦			Fuse 16A	230V/50Hz

Power supply

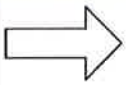
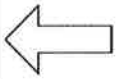
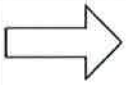
AC power supply for electric prime mover

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	MSB
Feed line Prime mover	L1 L2 L3	-XP1	L1 L2 L3	⇦			Fused	690V/50Hz
Earth connection	PE	-X1	4	⇦			Earth connection	

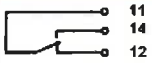
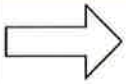
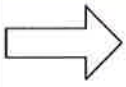
DC power supply

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	ESB
Feed line Back up power supply	24V DC (+) 24V DC (-, GND)	-X2	1 2	⇦			Fuse 16A	24V DC
Feed line indicators	24V DC (+) 24V DC (-, GND)	-X2	3 4	⇦			Fuse 4A	24V DC

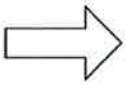
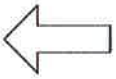
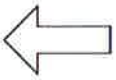
Interface to Power Management system

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	PMS
Power request		-X10	K1				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed for request
	24V DC, max. 1A	-X10 -X10	1 2					Power available
Unit ON		-X10	K4				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if unit is ON

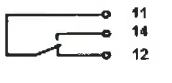
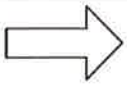
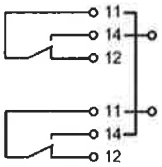
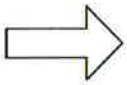
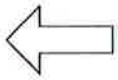
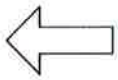
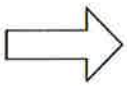
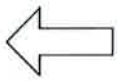
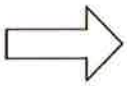
Interface to main-switchboard

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	MSB
Emergency stop active		-X10	K2				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if E-Stop is activated
Unit ON		-X10	K3				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if unit is ON

Interface to Autopilot

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	AP
Autopilot Mode ON		-X5	K1				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if mode is selected
	24V DC, max. 1A	-X5 -X5	1 2					Autopilot ready for service
Max load 500 Ohm (galvanic isolated input)	4 mA = -45° (port) 12mA = 0° (ahead) 20mA = +45° (stbd)	-X5 -X5	3 4				4-20mA(+) 4-20mA(-)	Setpoint value steering ±45°

Interface to DP system

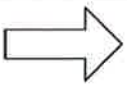
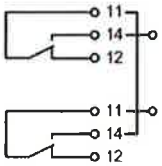
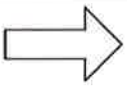
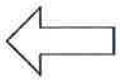
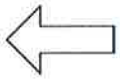
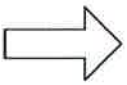
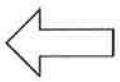
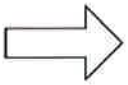
=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	DP
Thruster running (OPTION)		-X6	K3.11 K3.14 K3.12				30V DC, max. 2A 250V AC, max.2,5A	Thrust available
Thruster ready		-X6	K1.11 K1.14 K1.12	Contacts -X6.K1 and -X6.K2 connect one to another			30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if unit is ready
		-X6	K2.11 K2.14 K2.12				30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if mode is accepted
DP MODE ON (Manual control switched OFF)	24V DC, max. 1W	-X6 -X6	3 4					DP Request (From DP selection switch)
Max load 500 Ohm (galvanic isolated input, loop monitoring by thruster supplier)	4 mA = -180° (port) 12mA = 0° (ahead) 20mA = +180° (stbd	-X6 -X6	5 6				4-20mA(+) 4-20mA(-)	Setpoint value steering ±180°
Max load 500 Ohm (galvanic isolated output)	4-20mA(+) 4-20mA(-)	-X6 -X6	7 8				4 mA = -180° (port) 12mA = 0° (ahead) 20mA = +180° (stbd)	Feedback value steering ±180° (Loop monitoring from DP-supplier)
Max load 500 Ohm (galvanic isolated input, loop monitoring by thruster supplier)	4mA = 0rpm 20mA = 100%	-X6 -X6	9 10				4-20mA(+) 4-20mA(-)	Setpoint value speed 0-100%
Max load 500 Ohm (galvanic isolated output)	4-20mA(+) 4-20mA(-)	-X6 -X6	11 12				4mA = 0rpm 20mA = 100%	Feedback value speed0-100% (Loop monitoring from DP-supplier)

Relais description:

Thruster running (option)
X6.K3
As long as the thruster is able to create thrust force, this signal will be high. It is not essential whether control system is switched to local control, NFU or DP System.

Thruster ready
After reception of "request for DP" each thruster control system has to reply to the DP-system with "Thruster ready" signal of status high if the thruster would be ready to receive setpoint command from DP-system.
X6.K1
In case of any failure in the thruster control system which will disable the thruster to follow setpoint command the signal will be switched OFF.
X6.K2
Signal is high as long as the selector switch is switched to DP-control.

Interface to Joystick system

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	JS
Thruster running (OPTION)		-X7	K3.11 K3.14 K3.12				30V DC, max. 2A 250V AC, max.2,5A	Thrust available
Thruster ready		-X7	K1.11 K1.14 K1.12	Contacts –X7.K1 and –X7.K2 connect one to another			30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if unit is ready
		-X7	K2.11 K2.14 K2.12				30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if mode is accepted
JS MODE ON (Manual control switched OFF)	24V DC, max. 1W	-X7 -X7	3 4					JS Request (From JS selection switch)
Max load 500 Ohm (galvanic isolated input, loop monitoring by thruster supplier)	4 mA = -180° (port) 12mA = 0° (ahead) 20mA = +180° (stbd)	-X7 -X7	5 6				4-20mA(+) 4-20mA(-)	Setpoint value steering ±180°
Max load 500 Ohm (galvanic isolated output)	4-20mA(+) 4-20mA(-)	-X7 -X7	7 8				4 mA = -180° (port) 12mA = 0° (ahead) 20mA = +180° (stbd)	Feedback value steering ±180° (Loop monitoring from JS-supplier)
Max load 500 Ohm (galvanic isolated input, loop monitoring by thruster supplier)	4mA = 0rpm 20mA = 100%	-X7 -X7	9 10				4-20mA(+) 4-20mA(-)	Setpoint value speed 0-100%
Max load 500 Ohm (galvanic isolated output)	4-20mA(+) 4-20mA(-)	-X7 -X7	11 12				4mA = 0rpm 20mA = 100%	Feedback value speed0-100% (Loop monitoring from JS-supplier)

Relais description:

Thruster running (option)
X7.K3
As long as the thruster is able to create thrust force, this signal will be high. It is not essential whether control system is switched to local control, NFU or Joystick System.

Thruster ready
After reception of "request for Joystick" each thruster control system has to reply to the Joystick -system with "Thruster ready" signal of status high if the thruster would be ready to receive setpoint command from Joystick system.
X7.K1
In case of any failure in the thruster control system which will disable the thruster to follow setpoint command the signal will be switched OFF.
X7.K2
Signal is high as long as the selector switch is switched to Joystick -control.

Connection to the Conning system

=AZX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	CON
Status signals	Converter RS 232 to RS 422	A104	2 3	⇨			Proprietary sentence RS 422 Bandrate: 4,8kbit/s or 9,6kbit/s Data bits:8 Stop bits:1 Parity: None	

Following Information will be provided (according to NMEA 0183, Proprietary sentence)

- Currently selected speed of engine/drive motor (speed set point)
- Actual speed of engine/drive motor (speed feedback value)
- Actual propeller speed (propeller speed feedback value)
- Currently selected steering angle (azimuth set point)
- Actual steering angle (azimuth feedback value)
- Currently activated control desk
- Currently activated external system

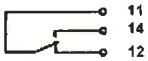
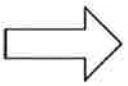
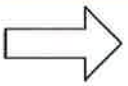
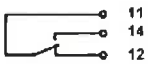
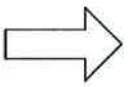
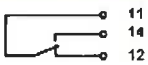
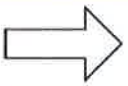
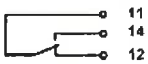
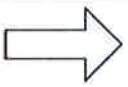
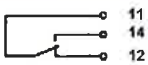
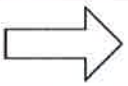
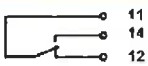
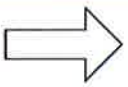
Interface to speed LOG

=AZX+SCS	signal specification	terminal no. SCHOTTEL		signal direction	terminal no. system supplier		signal specification	LOG
Ships speed	Converter RS 422 to RS 232	-A103	2 3	⇦			Data bus signal According IEC 61162 Used Telegram VHW or VTG	Ships speed

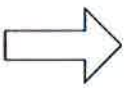
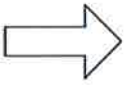
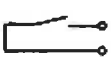
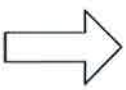
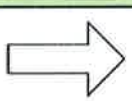
Interface to Ship alarm system

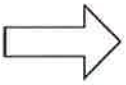
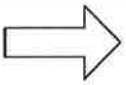
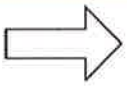
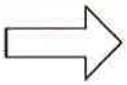
Switch box steering control system

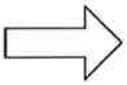
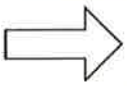
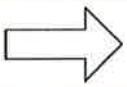
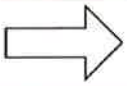
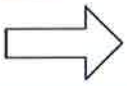
=AZX+SCS	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
indication	24V DC, max. 0,5A	-X4 1 -X4 2	⇦		⊸—⊸	Collective alarm of the unit
Failure AC/DC Converter	11 14 12	-X4 K1	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure feed line 24V DC	11 14 12	-X4 K2	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure control system	11 14 12	-X4 K3	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure NFU system	11 14 12	-X4 K4	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure FFU speed control (not used with integrated bridge systems)	11 14 12	-X4 K5	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure FFU steering control	11 14 12	-X4 K6	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
FFU steering locked	11 14 12	-X4 K7	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/12 is normal closed Delay time 1s
Failure external system	11 14 12	-X4 K8	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Shaft speed less 290rpm	11 14 12	-X4 K9	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s For suppressing lub oil flow alarm if foreseen

=AZX+SCS	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
Over temperature Switch cabinet		-X4 K17			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s
Prop. Motor Over temperature warning		-X4 K18			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s
Prop. Motor Break down windings		-X4 K19			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s
Converter Prop. Motor Over temperature warning		-X4 K20			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s
Converter Prop. Motor Break down		-X4 K21			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s
Failure Emergency stop system		-X4 K22			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s
Converter Prop. Motor Overload –reduce request		-X4 K23			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 0s

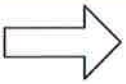
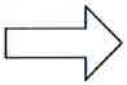
Switch box steering control power

=AZX+SCP	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
Main switch switched Off Contact N.C.		-X4 1 -X4 2			30V DC, max. 2A 250V AC, max. ,5A	
Phase failure feed line Contact N.C.		-X4 3 -X4 4			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Failure steering motors Contact N.C.		-X4 5 -X4 6			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Overload steering motors Contact N.C.		-X4 7 -X4 8			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s

Failure frequency converter Contact N.C.		-X4 9 -X4 10			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Overload frequency converter Contact N.C.		-X4 11 -X4 12			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Over temperature frequency converter Contact N.C.		-X4 13 -X4 14			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Failure set point frequency converter Contact N.C.		-X4 15 -X4 16			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s

=AZX+SCP	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
Over temperature brake resistor Contact N.C.		-X4 25 -X4 26			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Fault clima control switch box Contact N.C.		-X4 27 -X4 28			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Failure anti condensation heater steering motors		-X4 29 -X4 30			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Fault fans Steering motors Contact N.C		-X4 31 -X4 32			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s
Fault brake control Steering motors Contact N.C		-X4 33 -X4 34			30V DC, max. 2A 250V AC, max. ,5A	Delay time 1s

Thruster

=AZX+SRP	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
Lub oil level min Contact N.C.		-X2 11 -X2 12			24V DC, 0,5A	Contact is normal closed Delay time 10s
Lub oil temperature max Contact N.C.		-X2 13 -X2 14			24V DC, 0,5A	Contact is normal closed Delay time 5s

TWO (2) – SCHOTTEL TUNNEL THRUSTERS

TYPE STT 170 T

TWO FOR INSTALLATION IN BOW

Vessel type	: Dredger
Operation area	: Italy, Sea
class	: RINA
class notation	: C ✠ Hopper Dredger Coastal Area AUT-IMS DYNAPOS AM/AT

1. SCOPE OF SUPPLY

1.1 List of components supplied by SCHOTTEL

- 2x STT 0170 T
- Parts per thruster:
- separate lube oil tank
- Prime mover, Typ: Asynchrony frequency controlled electric motor
- 1x Forward bridge parts, configuration according to chapter desk configuration
- 1x Switch cabinet for SCHOTTEL control system and asynchrony frequency controlled electric prime mover
- per ship set:
- Tools:
  - For standard maintenance no special tools are required.
- 1x Spare parts to be supplied according to requirements of classification societies for simple maintenance and service work to be done by onboard personnel, basically consisting of:
  - Mechanical parts:
    Usually this includes hydraulic hoses (one of each size) and sealings.
  - Electrical parts:
    one set of printed circuit boards, relays and LEDs (depends on construction of electrical system)

1.2 Additional agreements

This technical specification describes SCHOTTEL standard units. In case of discrepancies and/or contradictions, the additional agreements shall prevail over all other parts of the technical specification.

Dimensions of air cooled IP 23 frequency control cabinets each: H X W X D = 2125 mm x 2000 mm x 600 mm
Cable entry from below.

2. TECHNICAL DATA (For each unit)

2.1. THRUSTER

Nominal input power	:	250 kW
Nominal input speed	:	1665 rpm
Gear reduction	:	3,071 :1
Max. allowed short time input torque	:	1888 Nm
Propeller diameter	:	990 mm
Propeller material	:	GS-CUAl10Fe5Ni5-C
Propeller Type	:	Fixed Pitch
Number of blades	:	4
Manufacturing standard	:	ISO 484/2-1981 (E). Tolerance Class II
Wearing ring in path of propeller	:	stainless steel, 5mm
Delivered tunnel length	:	1500 mm
Wall thickness of tunnel	:	20 mm
Wall thickness of hull	:	follows mm
Tunnel material	:	ship building steel grade A
Weight incl. propeller, oil header tank	:	about 1680 kg
Prime Mover type	:	electric motor
Prime Mover supply	:	SCHOTTEL supply
Max. Propeller tip speed	:	28,1 m/s
Max. Propeller blade load	:	324,77 kW/m2

2.2. POWER TRANSMISSION

An elastic coupling (SCHOTTEL supply) is fitted between the power input shaft of the tunnel thruster and the prime mover which is mounted directly vertical on the thruster unit.

3. DESIGN & CONSTRUCTION (For each unit)

3.1 GENERAL DESIGN FEATURES

INSTALLATION

The unit will be welded into the hull of the vessel with a vertical power input shaft arrangement. The thruster with its direct connection to the vessel is defined as part of the vessels hull.

TRANSVERSE TUNNEL

The transverse tunnel is a welded construction made of ship building steel grade A.

In the section of the propeller a stainless steel ring is welded into the tunnel against wear of the tunnel.

The tunnel is equipped with 2 outer stiffening rings and one central supporting ring. The outer stiffening rings are flat on the bottom side which allows easy welding to the frame structure and reduces deformations. For easier welding of the supplied tunnel into the vessel, tunnel ends are prepared with appropriate welding angles.

24,5 kg zinc anodes are welded onto the inside tunnel wall and on the supporting arm of the lower gear box. as protection against corrosion. They are fixed with small metal feet leaving a gap between anode and unit for sufficient final coating by the shipyard.
Anodes for tunnel extensions (shipyard supply) have to be supplied by shipyard. For each meter of tunnel extension at least 1,7 kg of anode mass has to be supplied and installed by the shipyard.

IMPORTANT REMARK TO BE RESPECTED BY THE SHIPYARD, REGARDING ANODE PROTECTION:
To ensure sufficient protection we recommend adding adequate anode protection fixed as described above on the tunnel parts which are built by the shipyard. Furthermore sufficient anodes have to be installed on the fore ship to protect the hull. If the anodes that protect the fore ship and tunnel are missing, then the anodes delivered with the tunnel thruster serve as the only protection for the complete fore ship. This means that these anodes will disappear within a few months and the thruster itself will serve as an anode which can lead to severe damage of the transverse thruster unit in a short period. In regular inspections, the anode mass should be examined and replaced when necessary.

In every case anode mass determined by SCHOTTEL should be controlled by a specialist responsible for the anodic protection of the complete vessel, considering the required protection period and region of operation of the vessel.

BOW THRUSTER GEAR UNIT

The housing of the lower gearbox which contains the bevel gear transmission is manufactured using high quality cast iron GGG 40.

The propeller shaft is made of steel with high tensile strength and is seated in roller bearings. Shaft sealing is achieved through radial shaft sealing rings.
High grade special stainless steel rings are used for rings which are in contact with seawater.

Precision bevel gears are made from high quality steel, case hardened and grinded after hardening. This results in a highly accurate tooth profile which ensures perfect matching of the bevel gear set and a high safety factor against contact stress.

The support plate of the underwater gear housing is welded to the tunnel. It is part of SCHOTTEL scope of supply.
All running surfaces of shafts, flanges etc. are coated with wear and corrosion resistant material.
The fixed pitch propeller is key-way mounted to the propeller shaft.

LUBRICATION

Lubrication is ensured by oil bath lubrication. Cooling of the oil is achieved by heat dissipation in the lower gearbox.

The separate oil header tank with level gauge is equipped with a sensor (24V DC) for alarm indication 'oil level too low'.
Note : This oil header tank has to be installed by the yard approx. 1 meter above loaded waterline.

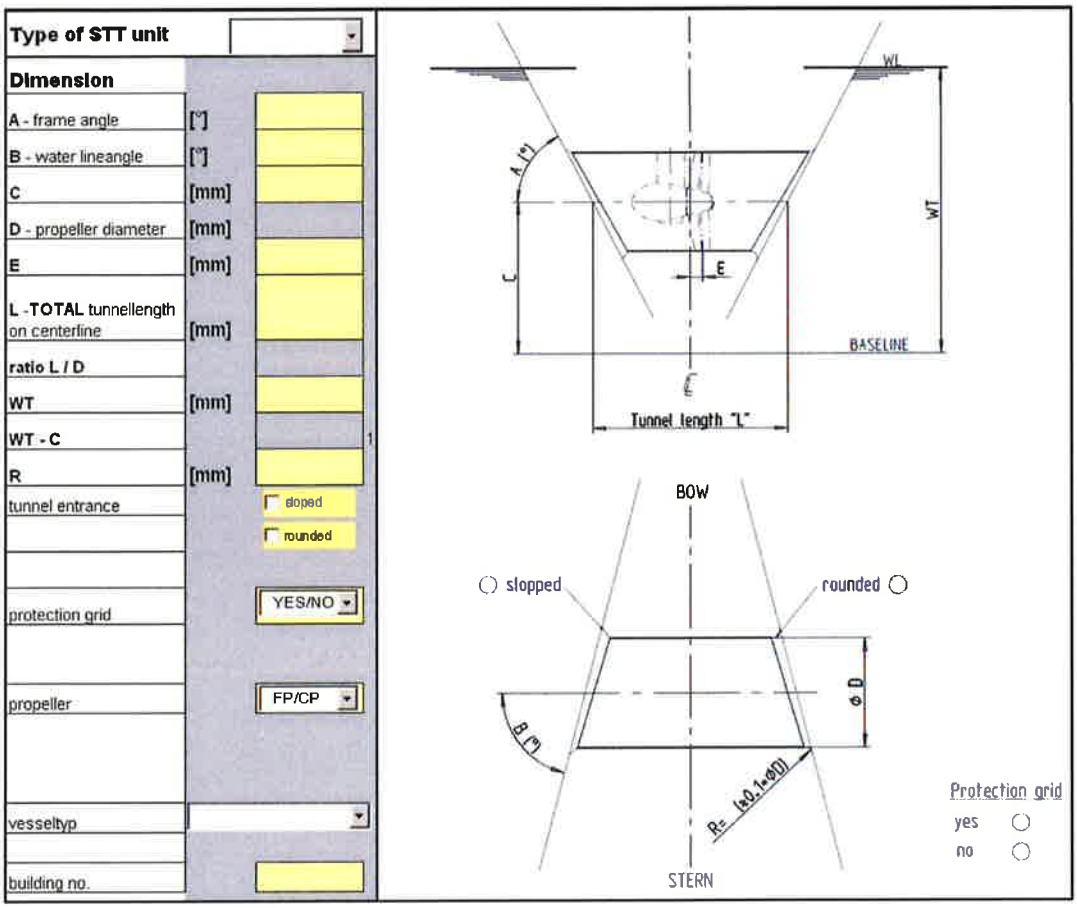
Connections between oil header tank and lower thruster unit are not SCHOTTEL scope of supply.

PROPELLER BLADE DESIGN

SCHOTTEL designs and produces tailor made propellerblades for every individual vessel and hull geometry. By doing this, thrust and efficiency are optimized.

For the designing of the propeller hull geometry in the tunnel area and the waterline details are necessary.

The below shown sheet „propeller data" has to be completed and issued latest 3 weeks after order, otherwise delivery will be delayed.



If ever the total tunnel length from port to starboard exceeds 6 meters the tunnel thruster cannot be used for the vessel. Please inquire quotation for thruster with next bigger propeller diameter!

The maximum allowable water depth of the tunnel thruster at full load of the vessel is 5m (distance propeller shaft – waterline).

Protection grids on tunnel ends have to be installed if vessel is ice classed (yard supply) In addition, the tunnel has to be below the ice belt of the vessel (the thruster unit itself has no ice-class).

SCHOTTEL does not recommend to use hull recesses (shaped as a tear drops) behind the tunnel ends of tunnel thrusters to reduce water turbulences. Experience shows that this has negative influence on thrust performance. The impact is not predictable.

4. AMBIENT CONDITIONS

Maximum environmental temperature during operation according to class requirements : 45°C

Maximum environmental operation conditions:
Mechanical system:

Ambient air temperature	: between 5°C and max. 55°C
Relative humidity of air	: max. 95% without condensation
Seawater temperature	: max. 32°C

Electric system:

Electric parts inside switchbox	: 0°C - 50°C
Bridge parts (inside)	: 0°C - 50°C
Bridge parts (outside)	: (-)20°C - 50°C
Relative humidity of air	: max. 95% without condensation
Vibration	: 0,7g

5. POWER SUPPLIES

For safe operation of the propulsion system SCHOTTEL requires the following power supply from the ship's sources:

Switch cabinet

- 400V/50Hz, 3Ph AC main power supply from the main switch board to the thruster control system (e.g. for ACDC converter or primer mover)

- 24 V DC (+30% /-25%) with a max. ripple of 1 V (fuse 16A) for emergency operation of the SCHOTTEL switch box.
- 24 V DC (+30% /-25%) with a max. ripple of 1 V (fuse 2 A) from the emergency switch box to the steering desk for emergency power supply of each thrust direction indicator.
- 230V/50Hz AC, for anti-condensation heating (independent source).

6. PRIME MOVER (For each unit)

FREQUENCY CONTROLLED ELECTRIC MOTOR

A frequency controlled asynchronous motor with squirrel-cage rotor will be used as prime mover.

Max. power	: 250 kW
Rated voltage	: 690 V
Rated frequency	: 56 Hz
Rated speed	: 1665 rpm
Rated duty	: S1
Construction form	: IM B3
Frame size	: 315
Pole pairs	: 2
Type of protection	: IP 23
Direction of rotation	: CW/CCW
Speed steps	: 0 - 100 %, frequency controlled
Class of insulation	: F
Motor cooling	: air-cooling

An anti-condensation heating prevents the winding from corrosion at stand still condition, rated voltage is 230V/50Hz. Incorporated temperature detectors protect the windings against excess temperatures (pre-warning / warning).

The electric motor has to be strutted to the ship by the shipyard.

Remark: All electrical components are rated for safe operation at an ambient temperature of 45°C
Shipyard shall ensure that bow thruster room is sufficiently ventilated.

7. ELECTRICAL SYSTEM (For each unit)

ELECTRIC CONTROL

GENERAL:
The electric equipment is designed for operation at ambient temperatures of up to 45°C. The equipment is designed for a drive with fixed pitch propeller that means with change of sense of rotation in 100%-0-100% speed.

CONTROL CUBICLE:
The control cubicle is a sheet steel construction, IP 23, cable entry from below and is provided for installation close to the electric motor.

The control cubicle is basically equipped with:

- 6 Pulse with THD Filter frequency converter
- Rated current of frequency converter: 290 A
- Main Contactor
- Motor protection relays
- Anti-condensation heating control for electric motor
- Interlock to tunnel thruster room fan
- "heavy duty inquiry" for power management system
- Relays for signalling of operation and failures
- Local control elements (NFU push button with indication) and thrust direction indicator

Passive harmonic filter unit
Due to strong impact of 6 Pulse Frequency Control to ship's board net due to THD (Total Harmonic Distortion), a THD Filter Unit reducing the Harmonic Distortions will be supplied. This filter unit will be installed into the control cubicle of the frequency control.

Remark
Frequency converters cause harmonic distortions on supply networks. Therefore a THD filter unit has been specified. A THD calculation has in every case to be effected for the supply network to check that these non linear consumers can be

integrated in the network without problems. In extreme cases additional filters or increased generator power can become necessary.

The thruster can be operated only if full electric power is made available on board net. This information is read from PMS via a closed potential free contact.
The electric power to be provided is minimum: 359,38 kVA (For each unit).

Panel configuration:
The following components will be delivered wired with a cable tree of 1,2 m length to terminal strips. The protection class of the control panel is IP54 (used inside), IP56 (used on open deck).

Labelling language : english

Main	Aft
Indicators: (per thruster) Indicator-Typ: 72x72 +Power loose Control-Panel: (per thruster) Mounting: loose drive control included Lever: (quantity, see note!) Mounting: mounted in Control-Panel Typ: Buk double Note: one panel with double lever and one panel without lever	not used

Main panels look like example below, moderate changes are possible:

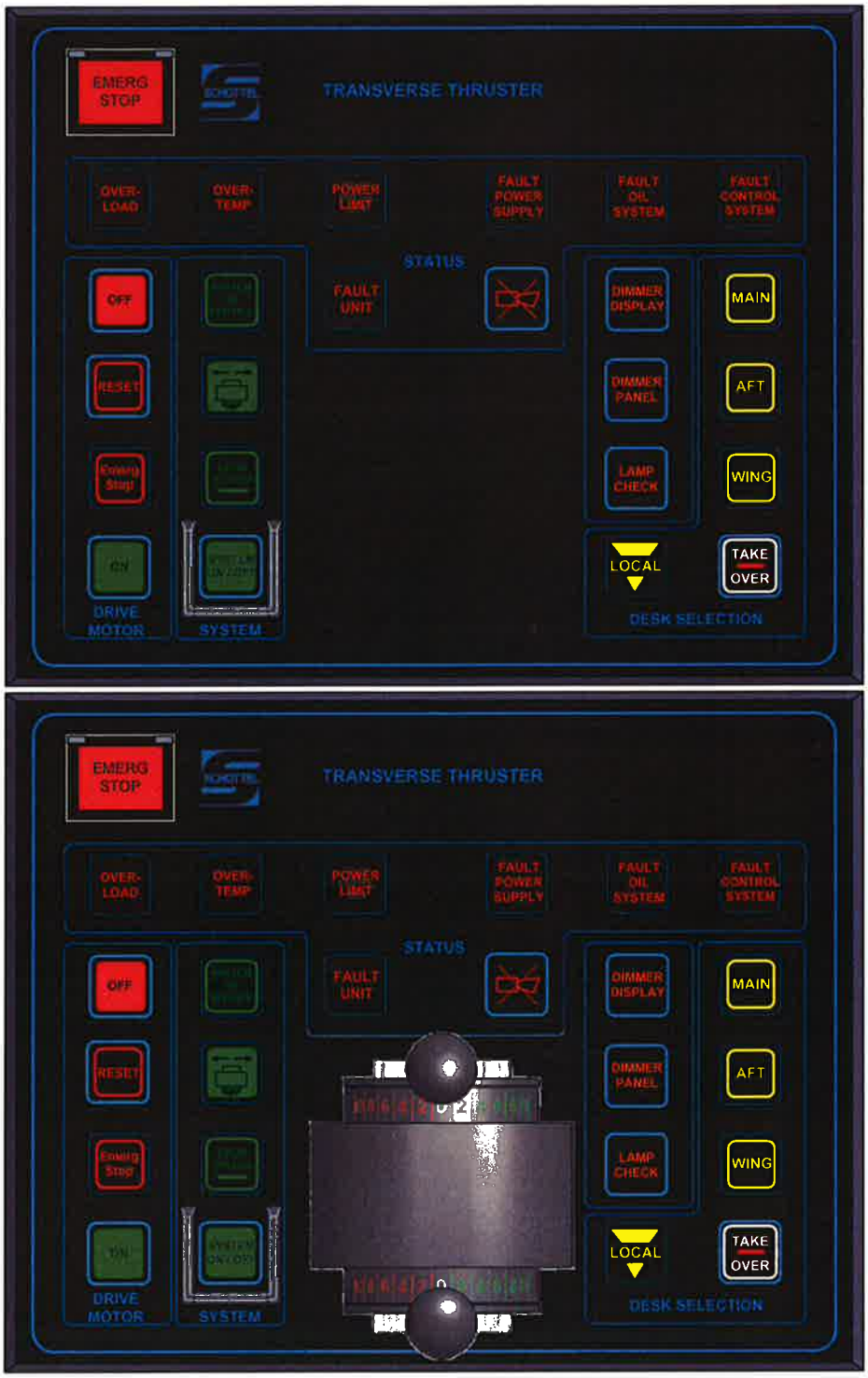


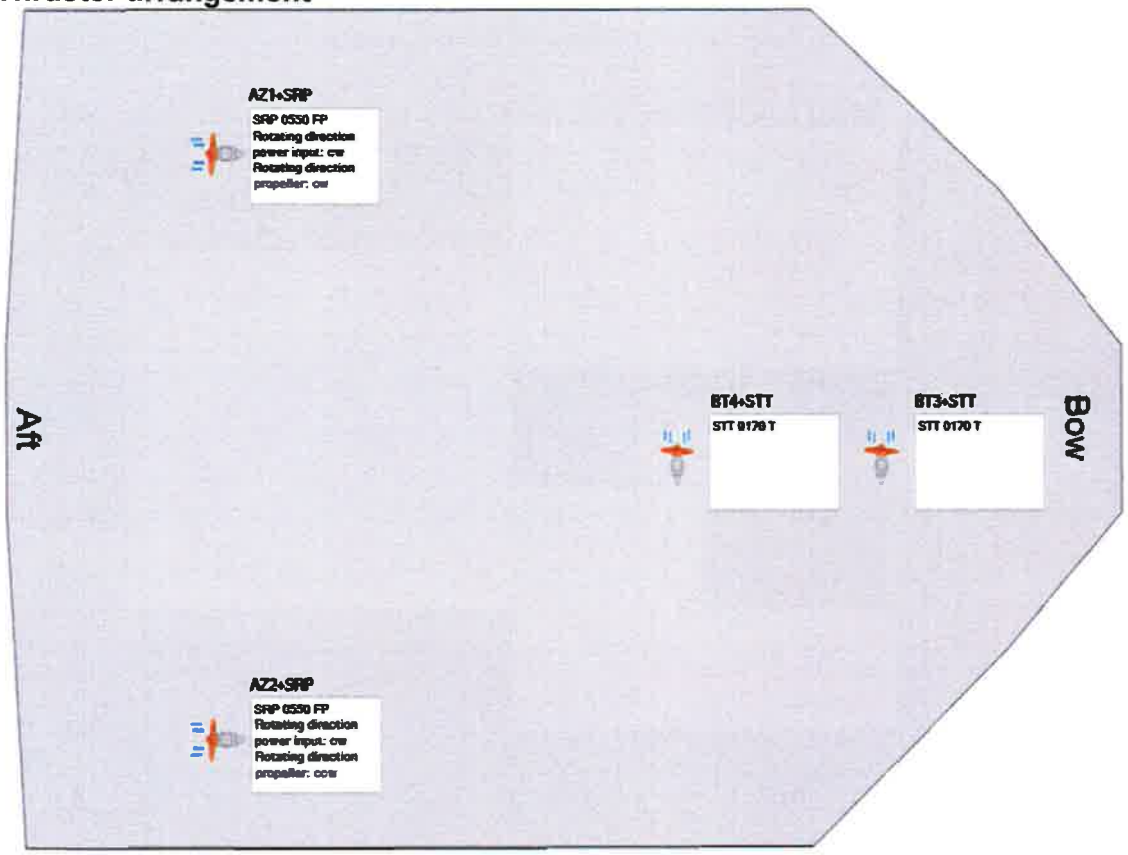
Figure 1: Schottel tunnel thruster FP panel for Main, Aft

Labelling language : english

Two (2) Wing panels for starboard and portside wing
not used

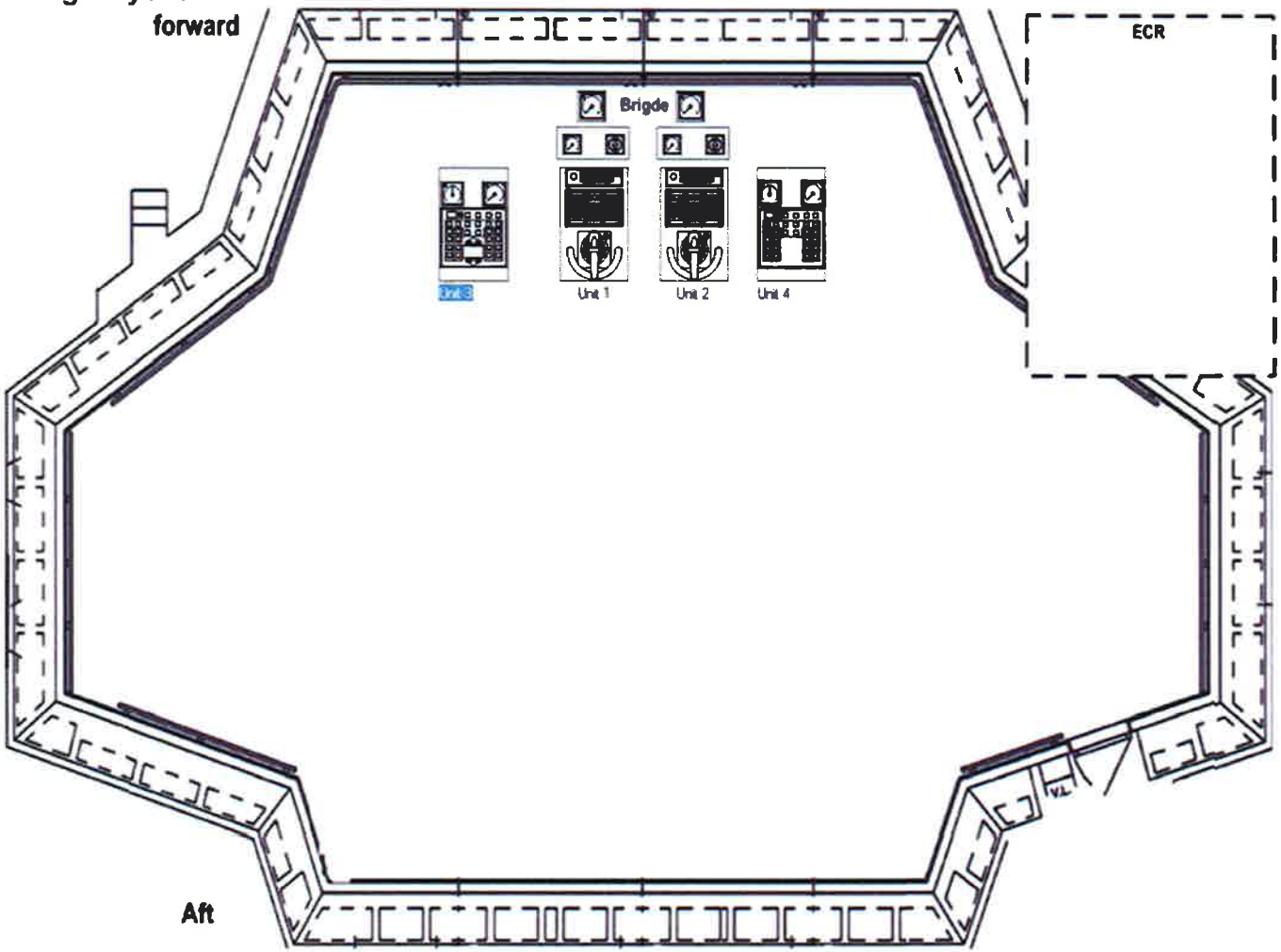
Technical Specification
MEV-130136-01 / order no. / order code word

Thruster arrangement



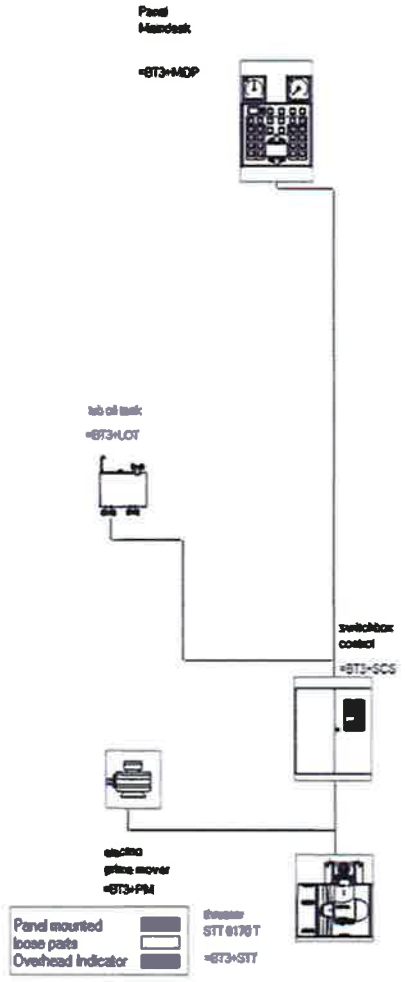
Technical Specification
MEV-130136-01 / order no. / order code word

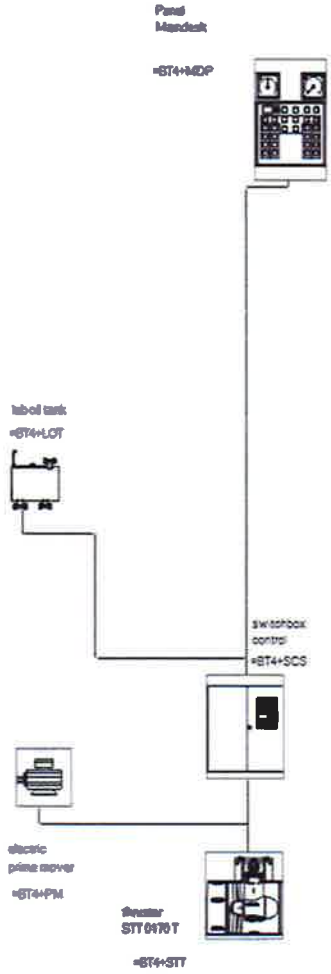
Bridge layout



Technical Specification
MEV-130136-01 / order no. / order code word

Unit arrangement





Interfaces

INTERFACE FOR DP SYSTEM

To operate the vessel via Dynamic Positioning system a DP-interface is included.
Remark: The system is designed for DP-operation according to the conditions in the Appendix.

The following signals are sent to the DP-system:
- speed feedback 4-20mA signal for 100% PS – 100% STB
- Potential free contacts "Thruster ready" and "thruster running"

Note: Loop monitoring of 4-20mA signals by DP-supplier

The following signals are sent by the DP-system:
- speed set point 4-20mA signal for 100% PS – 100% STB
- Potential free contact "DP ON"

Note: Loop monitoring of 4-20mA signals by SCHOTTEL

INTERFACE FOR CONNING SYSTEM

SCHOTTEL provides following signals to the Conning System (RS422, NMEA 0183):

- Actual speed value to engine (set point)
- Nominal value pitch setting (set point)
- Actual value pitch (feed back)
- Actual activated desk
- Actual activated external system

INTERFACE FOR JS SYSTEM

For positioning of the vessel an interface for a joystick system is included. The joystick system controls the thrust direction setting of the unit. For detailed information see the chapter "Interface description".

The following signals are sent to the JS-system:
- speed feedback 4-20mA signal for 100% PS – 100% STB
- Potential free contacts "Thruster ready" and "thruster running"

Note: Loop monitoring of 4-20mA signals by JS-supplier

The following signals are sent by the JS-system:
- speed set point 4-20mA signal for 100% PS – 100% STB
- Potential free contact "JS ON"

Note: Loop monitoring of 4-20mA signals by SCHOTTEL

Alarms

SCHOTTEL supplies potential free contacts to the ship warning unit. The alarm signals are available at the terminals of the switch cabinets and the connection boxes of the components. The signals for alarm suppressing are also connected to these terminals.

For indication of a common alarm on the SCHOTTEL desk control panels (if panels are in SCHOTTEL scope of supply) it is necessary that a potential free signal for "common alarm" will be delivered from the ship warning unit back to the SCHOTTEL control system.

All alarms that are required according to class requirements for rudder machinery will be indicated as "STATUS-SIGNALS" on the SCHOTTEL bridge panel (if panels are in SCHOTTEL scope of supply).

8. COATING AND PAINT STRUCTURE

Lower gearbox:
sand blasting SA 2 1/2 acc. DIN EN ISO 12944-4: 1998-07
2 layers BELZONA 1321 (Ceramic S-metal) coating each
approx. 270 µm

BELZONA 1321 (Ceramic S-metal) is highly resistant against electrolytic corrosion due to excellent dielectric properties and also protects against abrasion and cavitation in an excellent manner.

Tunnel:
sand blasting SA 2 1/2 DIN 55928
1 x 2K Epoxy-resin-primer approx. 40 µm
(final coating by shipyard after tunnel is welded
into the vessel and is therefore part of the hull)

Loose delivered metal parts to be installed inside ship:
Final paint: 7000, grey

Electric motor:
Final paint: grey

Electric switchboxes:
Final paint: grey, structure.

9. TECHNICAL DOCUMENTATION

- Installation documents by E-Mail in advance.
- Operation manuals (6 x paper & 1 x CD, language: english)

10. COMMISSIONING

Commissioning together with main propulsion units.

Important remark:
Please note that full power shall be available for successful commissioning. Furthermore upper tunnel end must be submerged by minimum one time propeller diameter below water line.
If one of both parameters is not fulfilled, a second journey and a second commissioning are necessary on customer's expenses.

If further days or travels are necessary which were not caused by SCHOTTEL, the SCHOTTEL Service Price List valid at the time of the performance applies. The same is to be applied for sea trial participation, if required.

11. TEST & CERTIFICATES

SCHOTTEL provides a quality assurance system in accordance with DIN ISO 9001.

Tunnel, gearbox, propeller and electric prime mover will be supplied with a classification certificate of the classification society RINA.

SCHOTTEL will effect the following tests:
- FAT for electrical & mechanical system

12. CONSERVATION & STORAGE

The bow thruster is supplied without oil in preserved condition (effective up to 6 months). If storage is required for a longer period, the thruster shall be filled with approved oil and rotated once per month.

The thruster(s) shall be stored in a dry and dust free area. During installation dust and welding near the lip seals shall be avoided and suitable protections shall be applied.

13. EXCLUSIONS

- Protection grids for tunnel ends
- Protection of all moving parts
- Installation and coupling of the system
- Electrical and hydraulic connections between SCHOTTEL-components and ship's sources
- Oil filling of all aggregates
- Alarm system (other than mentioned alarm switches)
- All parts not specifically indicated in the above specification as being part of our scope of supply

APPENDIX A: INTERFACE DESCRIPTION

Example

For azimuth thrusters:

=AZX+SCS, in interface list

X is the number of thruster
1 = Aft Azimuth thruster, port
2 = Aft Azimuth thruster, starboard

For retractable azimuth thrusters:

=RTX+SCS, in interface list

X is the number of thruster, enumeration of thruster numbers is from stern to bow

For bow thrusters:

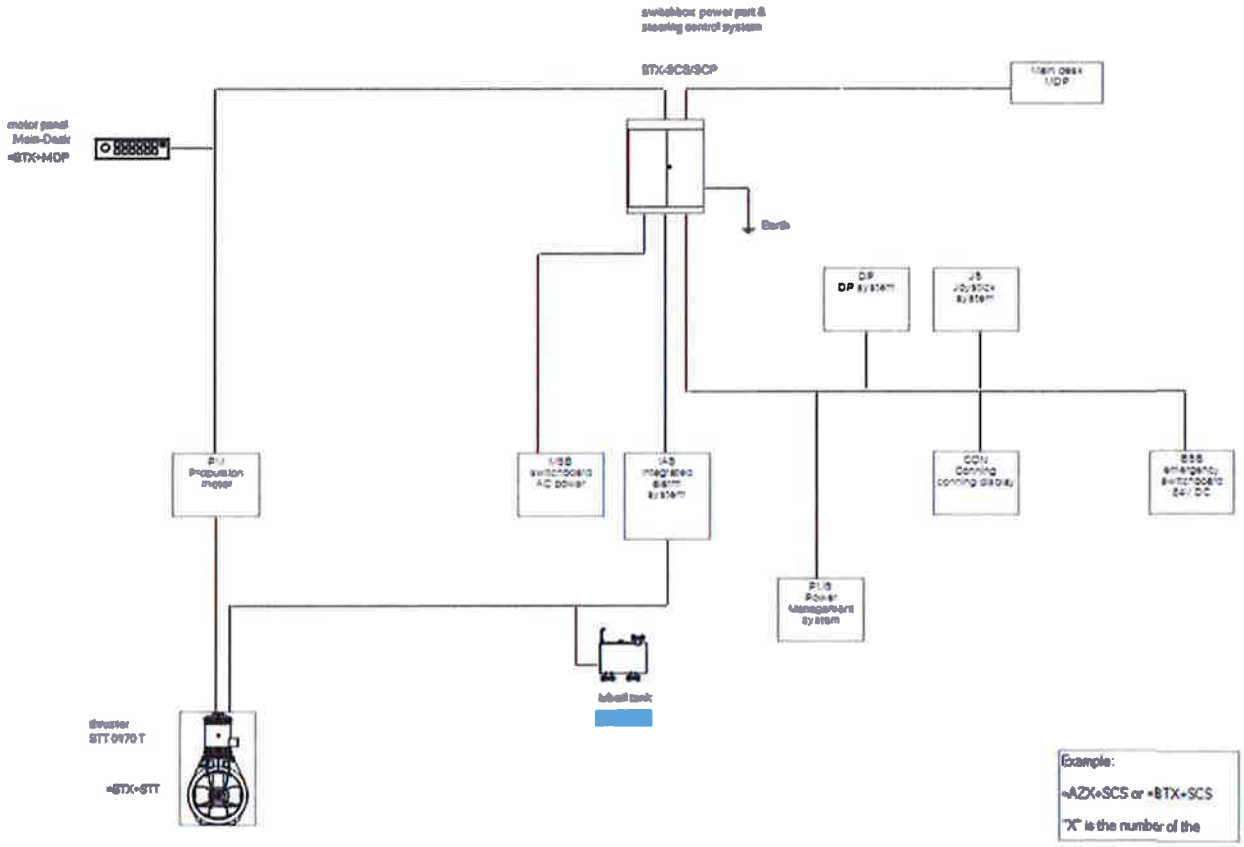
=BTX+SCS, in interface list

X is the number of thruster, enumeration of thruster numbers is from stern to bow

1 Contents

nomination	description
SCS	Switch cabinet steering control system
STT	tunnel thruster
MDP	Main Desk Panel
MSB	main switch board 400V/50Hz
PM	Propulsion motor
PMS	Power management system
IAS	integrated alarm system, warning unit
ESB	Emergency switchboard 24V DC
DP	Dynamic-Positioning-System
JS	Joystick-System
CON	Conning System
LOT	Lube oil tank

2 Overview Interfaces



Power supply

AC power supply control system

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	MSB
Feed line Control system	L1 L2 L3	-X1	1 2 3	⇦			Fused	400V/50Hz
Earth connection	PE	-X1	4	⇦			Earth connection	

Power supply

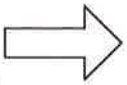
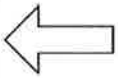
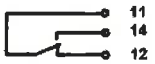
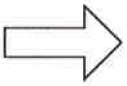
AC power supply for electric prime mover

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	MSB
Feed line Prime mover	L1 L2 L3	-XP1	L1 L2 L3	⇦			Fused	690V/50Hz
Earth connection	PE	-X1	4	⇦			Earth connection	

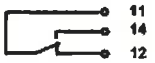
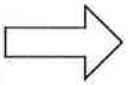
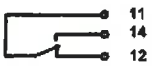
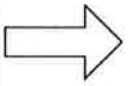
DC power supply

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	ESB
Feed line Back up power supply	24V DC (+) 24V DC (-, GND)	-X2	1 2	⇦			Fuse 16A	24V DC
Feed line indicators	24V DC (+) 24V DC (-, GND)	-X2	3 4	⇦			~ 50W Fuse 2A	24V DC

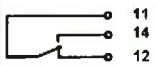
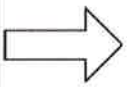
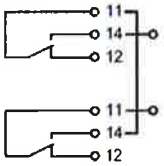
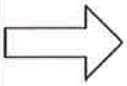
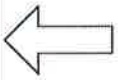
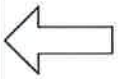
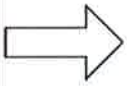
Interface to Power Management system

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	PMS
Power request		-X10	K1				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed for request
	24V DC, max. 1A	-X10 -X10	1 2					Power available
Unit ON		-X10	K4				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if unit is ON

Interface to main-switchboard

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	MSB
Emergency stop active		-X10	K2				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if E-Stop is activated
Unit ON		-X10	K3				30V/ DC, max.2A 250V AC max.2,5A	Contact 11/14 is closed if unit is ON

Interface to DP system

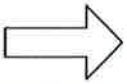
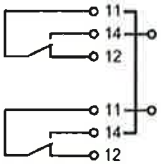
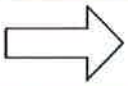
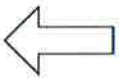
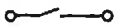
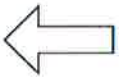
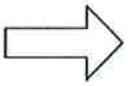
=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	DP
Thruster running (OPTION)		-X6	K3.11 K3.14 K3.12				30V DC, max. 2A 250V AC, max.2,5A	Thrust available
Thruster ready		-X6	K1.11 K1.14 K1.12	Contacts -X6.K1 and -X6.K2 connect one to another			30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if unit is ready
		-X6	K2.11 K2.14 K2.12				30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if mode is accepted
DP MODE ON (Manual control switched OFF)	24V DC, max. 1W	-X6 -X6	3 4					DP Request (From DP selection switch)
Max load 500 Ohm (galvanic isolated input, loop monitoring by thruster supplier)	4 mA = -100% (port) 12mA = zero 20mA = 100% (stb)	-X6 -X6	13 14				4-20mA(+) 4-20mA(-)	Setpoint value speed
Max load 500 Ohm (galvanic isolated output)	4-20mA(+) 4-20mA(-)	-X6 -X6	15 16				4 mA = -100% (PS) 12mA = zero 20mA = 100% (stb)	Feedback value speed 0-100% (Loop monitoring from DP-supplier)

Relais description:

Thruster running (option)
X6.K3
As long as the thruster is able to create thrust force, this signal will be high. It is not essential whether control system is switched to local control, NFU or DP System.

Thruster ready
After reception of "request for DP" each thruster control system has to reply to the DP-system with "Thruster ready" signal of status high if the thruster would be ready to receive setpoint command from DP-system.
X6.K1
In case of any failure in the thruster control system which will disable the thruster to follow setpoint command the signal will be switched OFF.
X6.K2
Signal is high as long as the selector switch is switched to DP-control.

Interface to Joystick system

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	JS
Thruster running (OPTION)		-X7	K3.11 K3.14 K3.12				30V DC, max. 2A 250V AC, max.2,5A	Thrust available
Thruster ready		-X7	K1.11 K1.14 K1.12	Contacts –X7.K1 and –X7.K2 connect one to another			30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if unit is ready
		-X7	K2.11 K2.14 K2.12				30V DC, max. 2A 250V AC, max.2,5A	Contact 11/14 is closed if mode is accepted
JS MODE ON (Manual control switched OFF)	24V DC, max. 1W	-X7 -X7	3 4					JS Request (From JS selection switch)
Max load 500 Ohm (galvanic isolated input, loop monitoring by thruster supplier)	4mA = 100% PS 12mA= zero 20mA = 100% Stb	-X7 -X7	13 14				4-20mA(+) 4-20mA(-)	Setpoint value thrust 0-100%
Max load 500 Ohm (galvanic isolated output)	4-20mA(+) 4-20mA(-)	-X7 -X7	15 16				4mA = 100% PS 12mA= 0 zero 20mA = 100% Stb	Feedback value thrust 0-100% (Loop monitoring from JS-supplier)

Relais description:

Thruster running (option)
X7.K3
As long as the thruster is able to create thrust force, this signal will be high. It is not essential whether control system is switched to local control, NFU or Joystick System.

Thruster ready
After reception of "request for Joystick" each thruster control system has to reply to the Joystick -system with "Thruster ready" signal of status high if the thruster would be ready to receive setpoint command from Joystick system.
X7.K1
In case of any failure in the thruster control system which will disable the thruster to follow setpoint command the signal will be switched OFF.
X7.K2
Signal is high as long as the selector switch is switched to Joystick -control.

Connection to the Conning system

=BTX+SCS	signal specification	terminal no.		signal direction	terminal no.		signal specification	CON
Status signals	Converter RS 232 to RS 422	A104	TA TB	⇨			Proprietary sentence RS 422 Bandrate: 4,8kbit/s or 9,6kbit/s Data bits:8 Stop bits:1 Parity: None	

Following Information will be provided (according to NMEA 0183, Proprietary sentence)

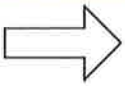
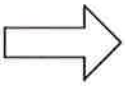
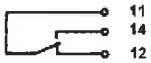
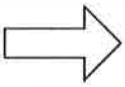
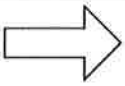
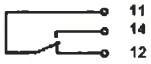
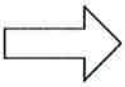
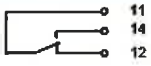
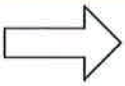
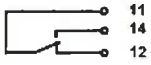
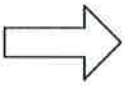
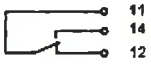
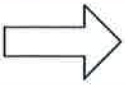
- Currently selected speed of engine/drive motor (speed set point)
- Actual speed of engine/drive motor (speed feedback value)
- Actual propeller speed (propeller speed feedback value)
- Currently selected steering angle (azimuth set point)
- Actual steering angle (azimuth feedback value)
- Currently activated control desk
- Currently activated external system

Interface to Ship alarm system

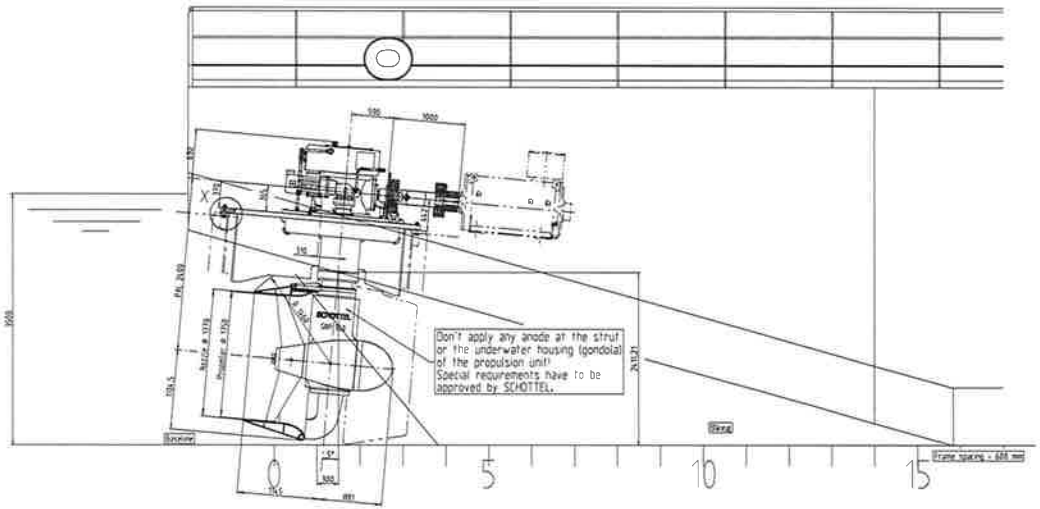
Switch box steering control system

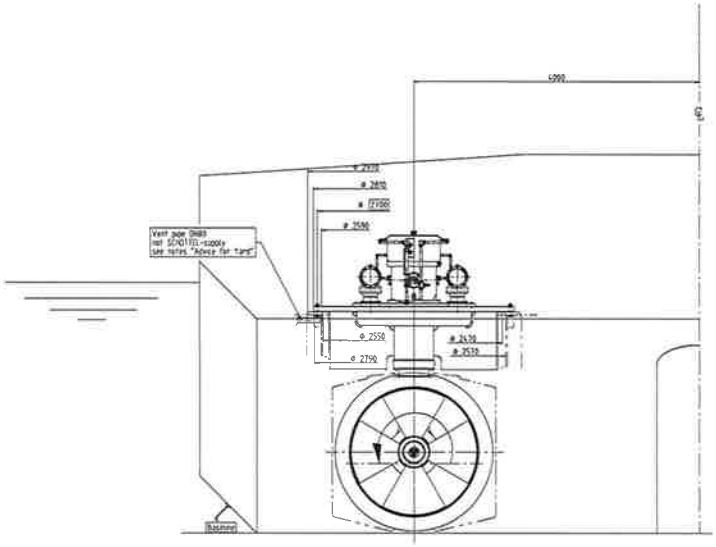
=BTX+SCS	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
indication	24V DC, max. 0,5A	-X4 1 -X4 2	⇦		⊸—⊸	Collective alarm of the unit
Failure AC/DC Converter	11 14 12	-X4 K1	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure feed line 24V DC	11 14 12	-X4 K2	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure control system	11 14 12	-X4 K3	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure NFU system	11 14 12	-X4 K6	⇨		30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s

Failure external system		-X4 K8			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Lube oil level min		-X4 K10			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s

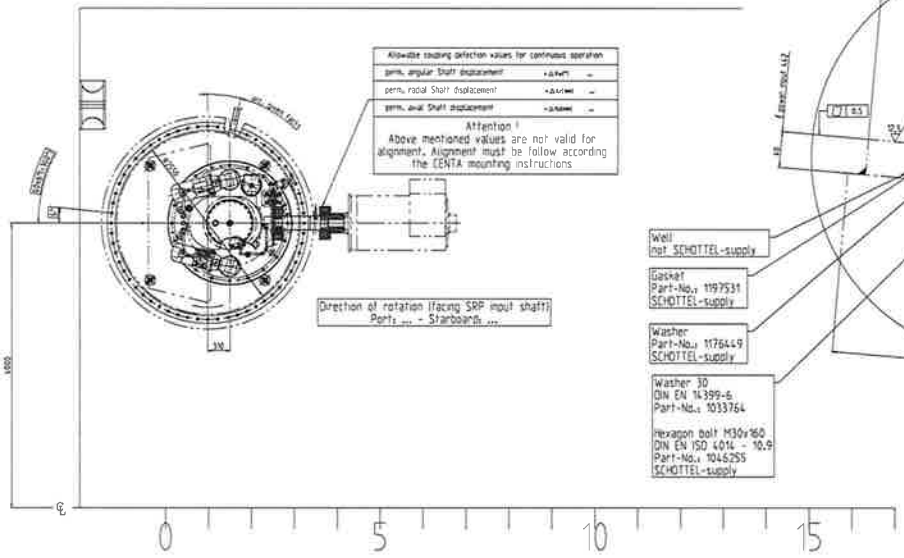
=BTX+SCS	signal specification	terminal no.	signal direction	terminal no.	signal specification	IAS
Phase failure feedline Prop. Motor		-X4 K16			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Over temperature Switch cabinet		-X4 K17			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Prop. Motor Over temperature warning 120°		-X4 K18			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Prop. Motor Break down windings 130°		-X4 K19			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Converter Prop. Motor Over temperature warning		-X4 K20			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Converter Prop. Motor Break down		-X4 K21			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Failure Emergency stop system		-X4 K22			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s
Converter Prop. Motor Overload –reduce request		-X4 K23			30V DC, max. 2A 250V AC, max. ,5A	Contact 11/14 is normal closed Delay time 1s

Propeller rotating sense seen from aft:
Ports ... Starboards ...

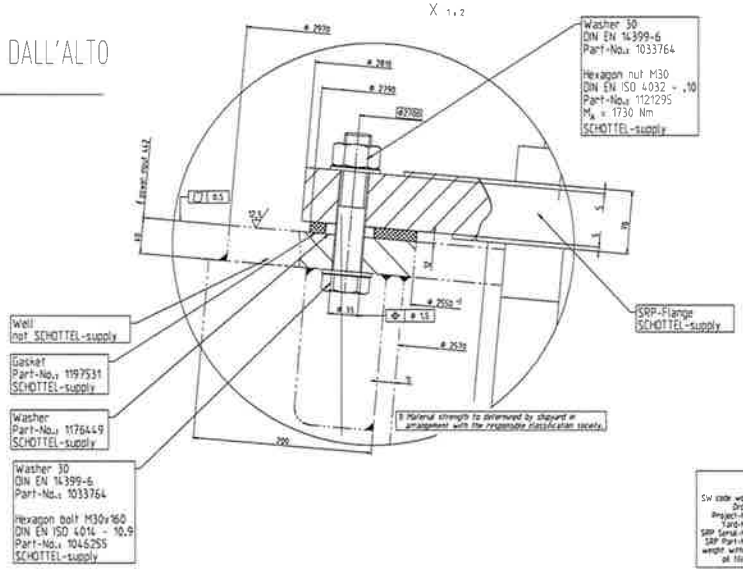




VISTA DALL'ALTO



X 1,2



Remark / Operating-, Mounting- and Maintenance instructions

Upon dispatch list of preliminary documentation & installation documentation:
[illegible]

Cathodic protection of hull in way of rudderpropeller has to be arranged by customer / shipyard !

All brackets have to be connected to hull structure!
The arrangement of the welding seam has to be executed according to the general welding regulations and the regulations of the classification societies!

ATTENTION! Before cutting of brackets protect bearings with covers!

Maximum ambient temperature of the engine room is 45° C / 113° F!

Distance between nozzle / propeller to propulsion-parts min. 300 mm !

Distance between nozzle / propeller and ship hull min. 50 mm !

All terminal boxes are provided with holes for the cabling which has to be insulated by the yard.
The glands are to be supplied by the yard.
The glands must be in accordance with the regulations DIN 89280 or VG 96773 or similar.
Glands which are mounted in terminal boxes outside the engine room have to be sealed additionally by means of heat-shrinkable sleeves.

Lateral vibration calculations of shaftlines are based on bearing foundation stiffness of min. 500 kN/mm. Vibration velocities of bearing supports < 4,5 mm/s

Alignment of bearings max. 0,5°
Stiffness of bearing foundation according to the requirements of the classification societies.

Check and confirmation of the exact alignment is required after the first run.
Our tolerances are valid for floating condition of vessel.

The room has to be ventilated as long as an intermediate shaft with bearings has been installed in there !

Advice for Yard, vent pipe has to be foreseen:
wall connection close below the flange, not connection any suitable position.
Vent pipe must lead from the wall to outside of vessel at an angle of min. 3° upwards.

The bolts for connecting of the clutch to flywheel and flywheel housing of engine are per SCHOTTEL scope of supply !

Where danger to people or material can be caused by rotating parts , a safety device has to be installed by user and / or operator .
The installation of guards is allowed by specialists only !

The distance of the switch box "CMS System" to the center of drive system must not exceed 15 m !

Installation of the SCHOTTEL equipment has to be carried out according to the latest version of drawings and manuals. Prior or preliminary issues are be disregarded upon receipt of the updated version. Construction and completeness/extend of the installation documentation are dependent on the scope of supply and will be updated and send in accordance with the progress of order parameters.

PORT	STARBOARD
SW code words: XXXXXXXX	SW code words: XXXXXXXX
Orders: ----	Orders: ----
Project-No.: MEV-130136-01	Project-No.: MEV-130136-01
Yard-No.: ----	Yard-No.: ----
SRP Serial-No.: ----	SRP Serial-No.: ----
SRP Part-No.: ----	SRP Part-No.: ----
weight without oil filling: -- kg	weight without oil filling: -- kg

Classification:
⊞ XXX ★
Vessel: XXX

ACHTUNG, ATTENTION!
Zeichnung ist nicht freigegeben.
Drawing not released.
no validity for manufacturing

VERSION ...

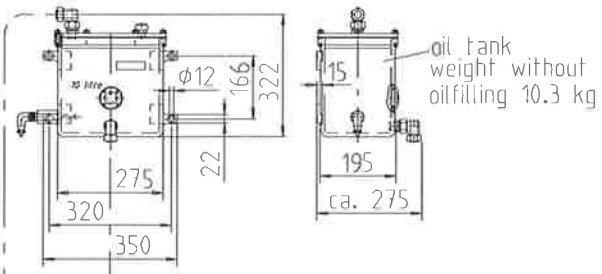
Approval procedure	date
first issue SCHOTTEL	
confirmation of ship-building relevant dimensions ! SCHOTTEL	00.00.2000
SHIPYARD	00.00.2000
Final drawing approval SCHOTTEL	as per drawing title "Norm"

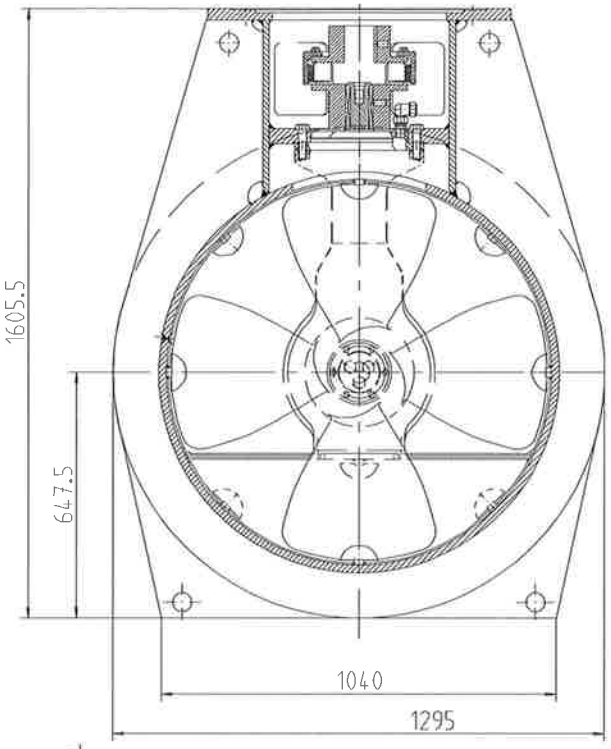
CAD-ZEICHNUNG:
for SRP 550 FP

EINBAUZEICHNUNG MEV-130136-01

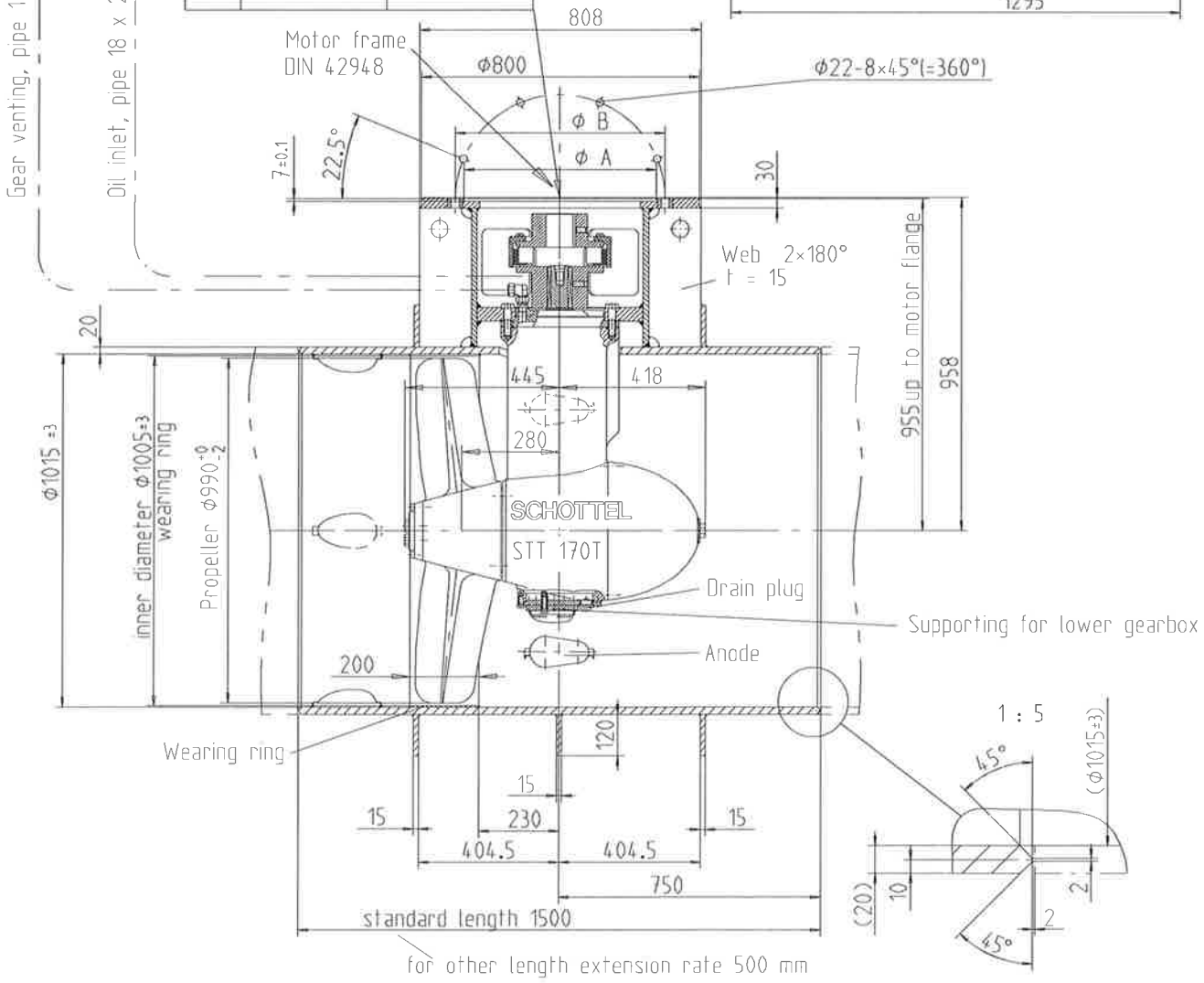
SCHOTTEL GmbH
MEV0136

Oil tank app. 1000 mm above load line installed.





	E-motor size 280	E-motor size 315
A	ϕ550 G8/h6	ϕ 680 G8/h6
B	ϕ 600	ϕ 740



Status	Scale	Alternaton Index	Drawing No. / Ident No.	Section / Page
09/11			STT170TLK-E-MOTOR-4 Propeller blades	2.4 / 43